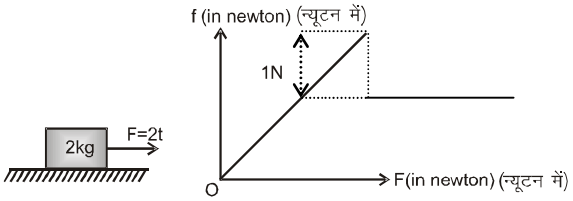
SECTION-1 : (Only One option correct type)

This section contains **12 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

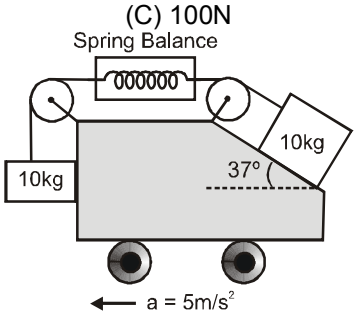
23. A block of mass m = (2 kg) is placed on a rough horizontal surface and is being acted upon by a time dependent force F = 2t Newton (where t is in second). The coefficient of static friction between the block and the horizontal surface is μ = 0.2. The frictional force f developed between the block and the surface versus force F plot is as shown. Assuming g = 10ms^{-2}, The velocity of the block at t = 4s will be:



(A) 1.5 m/s (B) 2m/s (C) 3 m/s (D) 4 m/s

24. A car is moving with 5m/s^2 acceleration horizontally as shown. There is no friction at any contact surface. The reading of a light spring balance at the instant shown is [Take g = 10 m/s^2]
(Assume the hanging part of string is vertical and the blocks does not oscillate while the reading of spring balance is being taken)

(A) zero (B) 70N (C) 100N (D) None of these

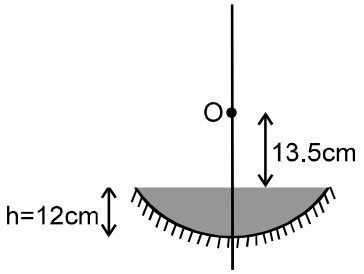


25. A satellite with mass 2000 kg and angular momentum magnitude 2 × 10^{12} kg.m^2/s is moving in an elliptical orbit around a planet. The rate at which area is being swept out by the satellite around the planet, is equal to

(A) 1 × 10^9 m^2/s (B) 5 × 10^9 m^2/s (C) 5 × 10^8 m^2/s (D) 4 × 10^{15} m^2/s

26. A concave mirror of radius of curvature 40 cm is filled with water (n = 4/3) upto a height of 12 cm. A point object O is kept on the principal axis of the mirror at height 13.5 cm from the water surface. The final image formed after refraction at water surface, reflection at mirror and again refraction at water surface in succession is situated at.

(A) 36 cm above the water surface (B) 24 cm above the water surface
(C) 20 cm above the water surface (D) 12 cm above the water surface



PHYSICS

27. Consider a uniformly charged solid non conducting sphere of radius R and charge Q. Consider three spherical regions centered at the centre of the uniformly charged solid non conducting sphere, given below :

Region (1) $R_1 \geq r \geq 0$

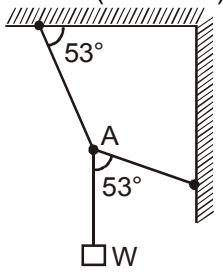
Region (2) $R_2 \geq r \geq R_1$

Region (3) $\infty \geq r \geq R_2$

If electrostatic potential energy stored in each of the three regions is equal find $\frac{R_2}{R_1}$:

(A) 2 (B) 3 (C) 1 (D) 4

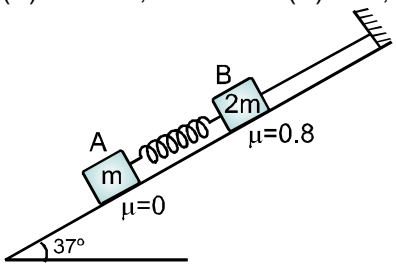
28. For the equilibrium condition shown, the cords are strong enough to withstand a maximum tension 100 N. What is the largest value of W (in newton) that can be suspended :



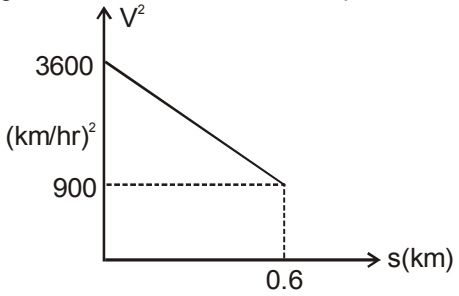
(A) 100 N (B) 35 N (C) 80N (D) 55 N

29. Initially both the blocks are at static equilibrium. Then the acceleration of blocks A & B just after cutting the string is respectively : (g = 10 m/s²)

(A) 7.5 m/s², 7.5 m/s² (B) 2.6 m/s², zero (C) zero, 2.6 m/s² (D) zero, zero



30. A graph between the square of speed of a particle moving along a straight line and the distance 'S' moved is shown in the figure. The acceleration of the particle in km/hr² is –

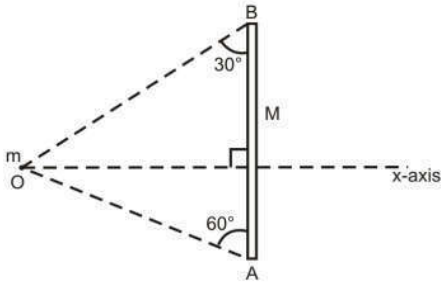


(A) 2250 (B) 225 (C) –2250 (D) –225

31. A force $\vec{F}$ is applied to a block (m = 6 kg) at rest on a fixed inclined plane of inclination 30°. The force is horizontal and parallel to surface of inclined plane. Maximum value of F so that block remains at rest is 40N. The coefficient of friction between the block and surface is :

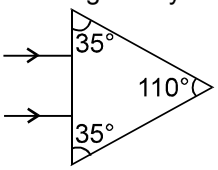
(A) $\frac{2}{\sqrt{3}}$ (B) $\sqrt{3}$ (C) $\frac{5}{3\sqrt{3}}$ (D) $\frac{5\sqrt{3}}{2}$

32. AB in a uniform rod of mass M and a point mass m is placed at origin as shown in figure. The direction of force on point mass m due to rod makes an angle θ with positive x-axis, where θ is. (Positive angle means angle measured anti-clockwise from x-direction)



(A) + 45° (B) – 30° (C) + 30° (D) + 15°

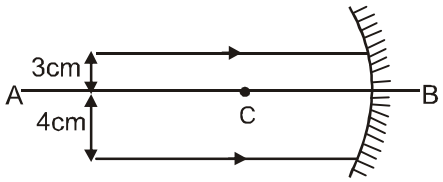
33. Two parallel beams of light pass through an isosceles prism of refractive index 1.4 as shown in the figure. The angle between the two emergent rays is : [$\sin 35^0 = 0.57$, $\sin^{-1}(0.798) = 53^0$]



(A) 36^0 (B) 27^0 (C) 47^0 (D) 60^0

34. Two rays are incident on a spherical concave mirror of radius R = 5 cm and rays are parallel to a line AB which passes through the centre C. The rays are at perpendicular distances 3 cm and 4 cm from AB respectively as shown. Find the distance between the points at which these rays intersect the line AB after reflection -

(A) $\frac{25}{24}$cm (B) $\frac{24}{25}$cm (C) zero (D) $\frac{1}{3}$cm



SECTION-2 : (One or more option correct type)

This section contains **10 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** are correct.

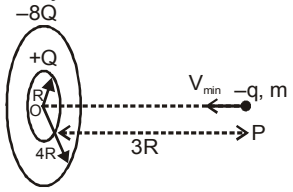
35. As shown in diagram there are two fixed uniformly charged concentric coplanar conducting rings having radius 'R' and 4R and charges '+Q' and '–8Q' respectively. A charge particle of mass 'm' & charge '–q' is projected along the axis of rings from point 'P' so that particle can just reach the centre of rings (point 'O'). (Assume Qq > 0.)

(A) required minimum velocity is zero

(B) speed of particle at the position 'O' will be non zero

(C) particle perform oscillatory motion about 'O'

(D) particle will not perform oscillatory motion about 'O'



PHYSICS

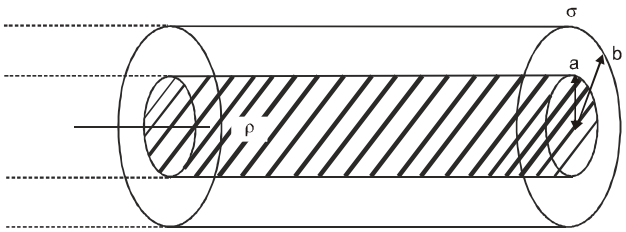
36. A long co-axial cable carries a uniform volume charge density ρ on inner cylinder and uniform surface charge density σ on outer cylinder. If radius of inner cylinder is 'a' and radius of outer cylinder is 'b'. It is found that this infinite cable is electrically neutral then which of the following is/are **correct**.

(A) $\frac{\sigma}{b^2}+\frac{\rho}{2a}=0$

(B) $\frac{\sigma}{a^2}+\frac{\rho}{2b}=0$

(C) Electric field outside the cable increases linearly with radial distance

(D) Electric field will be zero outside the cable



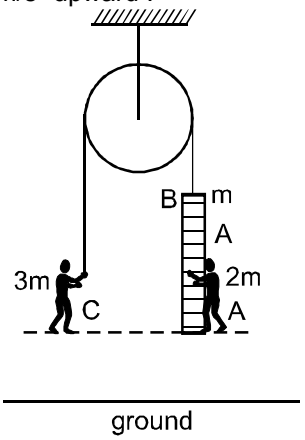
37. Man A of mass 2m is standing on a ladder of mass m. Ladder is attached with an inextensible light string and man C of mass 3m is holding the other end of string. Initially, the whole system is at rest. Assume whole system is at sufficient height and pulley is frictionless. Also A and C are at same horizontal level. Then choose the correct options.[g = 10 m/s^2].

(A) If man A starts climbing up on the ladder with a constant acceleration of 4 m/s^2 w.r.t ground then, the vertical distance between A and C after 1 sec is 1 m.

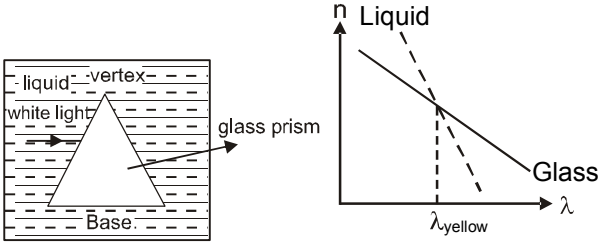
(B) If man C starts climbing up on the rope (while A remain at rest with respect to ladder) with constant acceleration of 4 m/s^2 with respect to ground then, the vertical distance between A and C after 1 sec is 2 m.

(C) If both man A and C starts climbing up with constant acceleration 4 m/s^2 with respect to ground then, acceleration of ladder is 4 m/s^2 upward .

(D) If both man A and C starts climbing up with constant acceleration 4 m/s^2 with respect to ground then, acceleration of ladder is 3 m/s^2 upward .



38. In a liquid, a glass prism is immersed. The curves showing the refractive index n as a function of wavelength λ for glass and liquid are as given in the figure. When white light is incident on the prism parallel to the base then :



PHYSICS

(A) Blue ray is deviated towards vertex
(B) Red ray is deviated towards base
(C) Yellow ray travels without deviation
(D) there is no dispersion

39. When a dipole is placed inside a cavity in a solid neutral conducting body :
(A) No charges are induced on the inner surface of cavity
(B) No charges are induced on the outer surface of conducting body
(C) Everywhere outside the body electric field due to dipole is zero
(D) Everywhere outside the body net electric field is zero

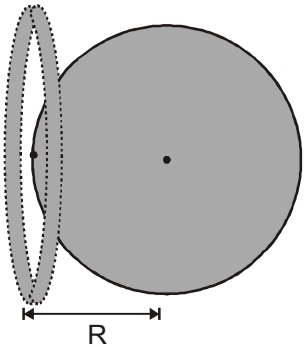
40. An uncharged conducting sphere of radius R is placed near a uniformly charge ring of radius R. Total charge on ring is Q. The centre of sphere lies on axis of ring and distance of centre of sphere from centre of ring is R.

(A) Potential at centre of ring is $\frac{KQ}{R}$

(B) Potential at centre of ring is $\frac{KQ}{\sqrt{2}R}$

(C) Potential at centre of ring due to conducting sphere is zero

(D) Potential at centre of conducting sphere is $\frac{KQ}{\sqrt{2}R}$



41. Three point masses A,B,C each of mass m are moving on the same circular path and are always equidistant from each other. The radius of circle is R and the speed of each mass is same and equal to V. The only force acting on each mass is the graviational force because of the other two masses. Choose the correct statement.
(A) power of the graviational force by A on B is non-zero
(B) power of the graviational force by A on B is zero

(C) power of the total graviational force on A in the frame of B is $\frac{\sqrt{3}mV^3}{2R}$

(D) the ratio of magnitude of relative velocity of A with respect B and A with respect to C is 1 : 1

42. An artificial satellite is moving in a circular orbit around the earth with a speed equal to half the magnitude of escape velocity from the earth surface. Which of the following Options is/are correct : (assume radius of the earth R = 6400 km, g at the earth surface is $10ms^{-2}$, neglect the air resistance)
(A) Height of the satellite above the earth surface is 6400 km
(B) If satellite is suddenly stopped in its orbit and allowed to fall freely into the earth. Then it will hit the earth surface with 8 km/s.
(C) If satellite is suddenly stopped in its orbit and allowed to fall freely into the earth. Then during its fall total mechanical energy of satellite, in the gravitational field of the earth, remains constant.
(D) If satellite is suddenly stopped in its orbit and allowed to fall freely into the earth. At the given instant its acceleration is $5\ m/s^2$

PHYSICS

43. A luminous point object is placed at O, whose image is formed at I as shown in figure. Line AB is the optical axis. Which of the following statement is/are correct ?

(A) If a lens is used to obtain the image, then it must be a converging lens and its optical centre will be the intersection point of line AB and OI.

(B) If a lens is used to obtain the image, then it must be a diverging lens and its optical centre will be the intersection point of line AB and OI.

(C) If a mirror is used to obtain the image then the mirror must be concave and object and image subtend equal angles at the pole of the mirror.

(D) I is a real Image.

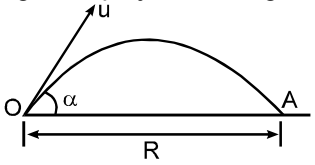
44. A particle projected from O and moving freely under gravity strikes the horizontal plane passing through O at a distance R from starting point O as shown in the figure. Then:

(A) there will be two angles of projection if $Rg < u^2$

(B) the two possible angles of projection are complementary

(C) the product of the possible times of flight from O to A is $2R/g$

(D) there will be more than two angles of projection if $Rg = u^2$



MOCK TEST -2

PHYSICS

SECTION-1 : (One or more option correct type)

This section contains **15 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** are correct.

21. A block of mass 10 kg placed in a car going down on an incline of inclination 60°. If the coefficient of friction between the block and car floor is $\frac{1}{\sqrt{3}}$. Find the maximum acceleration a of car down the incline so that the block doesn't slip on the car surface.

(A) $a = \frac{g}{\sqrt{3}}$ (B) $a = \frac{2g}{\sqrt{3}}$ (C) $a = \frac{\sqrt{3}g}{2}$ (D) None of these

22. A satellite revolves around a planet in circular orbit of radius R (much larger than the radius of the planet) with a time period of revolution T. If the satellite is stopped and then released in its orbit (Assume that the satellite experiences gravitational force due to the planet only).

(A) It will fall into the planet

(B) The time of fall of the satellite into the planet is nearly $\frac{T}{\sqrt{8}}$

(C) The time of fall of the satellite into the planet is nearly $\frac{\sqrt{2}T}{8}$

(D) It cannot fall into the planet so time of fall of the satellite is meaningless

23. Select the incorrect statements from following.

(A) conversing lens can not form real image for virtual object

(B) diverging mirror can not form real image for real object

(C) conversing mirror can not form real image for virtual object

(D) diverging lens can not form real image for virtual object

24. Four point masses each of mass m are placed on vertices of a regular tetrahedron. Distance between any two masses is r.

(A) Gravitation field at centre is zero

(B) Gravitation potential at centre is $\frac{-4Gm}{r}$

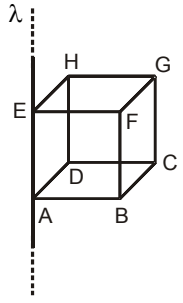
(C) Gravitation potential energy of system in $\frac{-6Gm^2}{r}$

(D) Gravitation force on one of the point mass is $\frac{\sqrt{6}Gm^2}{r^2}$

25. An infinite long line charge of charge per unit length λ is passing through one of the edge of a cube. Length of edge of the cube is ℓ. (see figure.)

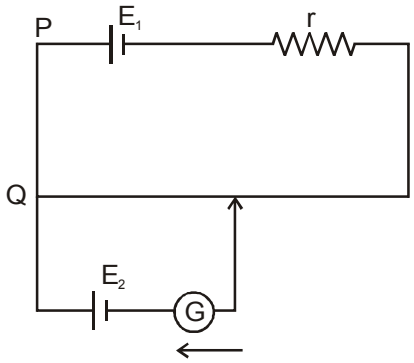
(A) Total flux linked with cube is $\frac{\lambda\ell}{2\varepsilon_0}$ (B) Total flux linked with BADC is $\frac{\lambda\ell}{8\varepsilon_0}$

(C) Total flux linked with BCGF is $\frac{\lambda\ell}{8\varepsilon_0}$ (D) Total flux linked with ABFE is zero

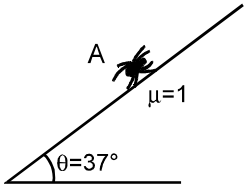


PHYSICS

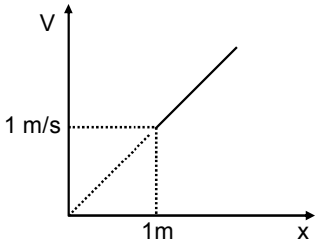
26. In the potentiometer circuit of given figure the galvanometer reveals a current in the direction shown wherever the sliding contact touches the wire. This could be caused by :
(A) E_1 being too low (B) r being high (C) a break in PQ (D) E_2 being too low.



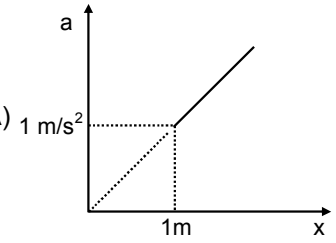
27. An insect of mass m, starts moving on a rough inclined surface from point A. As the surface is very sticky, the coefficient of friction between the insect and the incline is $\mu = 1$. Assume that it can move in any direction; up the incline or down the incline then ($g = 10\ m/s^2$) : Choose the correct options :
(A) The maximum possible acceleration of the insect can be 14 m/sec^2
(B) The maximum possible acceleration of the insect can be 2 m/sec^2
(C) The insect can move with a constant velocity
(D) no friction force will act on insect when it moves with constant velocity

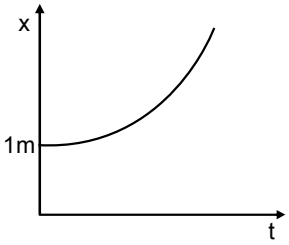


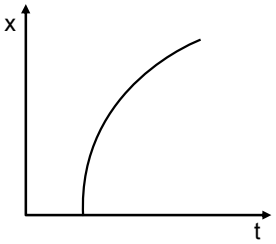
28. A particle is moving in a straight line according to graph given below (At t = 0, x = 1m, v = 1 m/s)

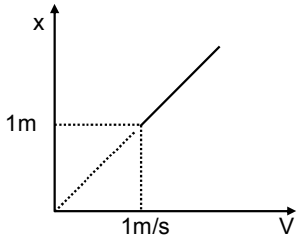


then:

(A) 

(B) 

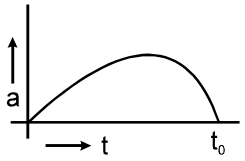
(C) 

(D) 

PHYSICS

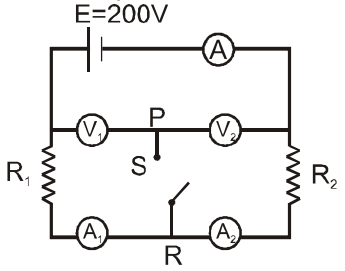
29. A particle is moving in a straight line whose acceleration versus time graph is given. Assume that initial velocity is in the direction of acceleration. Then which of the statement(s) is/are correct between time t = 0 to t = t_0.

(A) Velocity first increases then decreases, displacement always increases
(B) Total change in velocity during the given interval is zero.
(C) Displacement always increases
(D) Velocity always increases



30. In the circuit shown in the figure V_1 and V_2 are two voltmeters of resistance 3000Ω and 2000Ω respectively. R_1 = 2000Ω, R_2 = 3000Ω and E = 200 V. All the ammeters and cell are ideal :

(A) Reading of voltmeter V_1 in volt is 120 Volt, when 'S' is open.
(B) Reading of voltmeter V_1 in volt is 100 Volt, when 'S' is closed.
(C) Reading of ammeter A is 100 milliampere, when 'S' is closed.
(D) Reading of ammeter A_1 is 50 milliampere, when 'S' is closed.



31. The radii of a spherical capacitor are equal to a and b (b > a). The space between them is filled with a dielectric of dielectric constant K and resistivity ρ. At t = 0, the inner electrode is given a charge q_0. Choose the correct options :

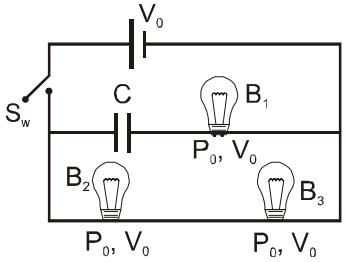
(A) Charge q on the inner electrode as a function of time is given by $q = q_0 e^{-\frac{t}{\rho K \varepsilon_0}}$
(B) In a short time, the charge on the inner electrode will become zero
(C) After a long time, the charge on the outer sphere will become q_0
(D) The total amount of heat generated during the spreading of charge will be given by $H = \left(\frac{1}{a} - \frac{1}{b}\right)\frac{q_0^2}{8\pi\varepsilon_0 K}$

32. An uncharged capacitor is connected in circuit as shown in figure. Power ratings of bulbs are given in diagram. At t = 0 switch is closed select correct alternative(s) :

(A) At t = 0 power consumption in circuit is $\frac{3P_0}{2}$.

(B) After a long time power consumption in circuit is $\frac{P_0}{2}$.

(C) Brightness of B_1 decreases with time.
(D) Initially Brightness of bulb B_2 is less than brightness of B_1, but later on after certain time B_2 will be brighter.



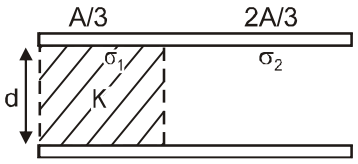
33. A parallel plate capacitor of area A and separation d is charged to potential difference V and removed from the charging source. A dielectric slab of constant K = 5, thickness d and area $\frac{A}{3}$ is inserted, as shown in the figure. Let σ_1 be free charge density at the conductor-dielectric surface and σ_2 be the charge density at the conductor-vacuum surface.

(A) The electric field will have the same value inside the dielectric as in the free space between the plates.

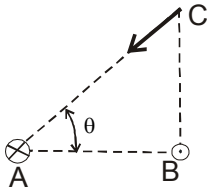
(B) The ratio $\frac{\sigma_1}{\sigma_2}$ is equal to $\frac{1}{5}$.

(C) The new capacitance is $\frac{7\in_0 A}{3d}$

(D) The new potential difference is $\frac{3}{7}V$

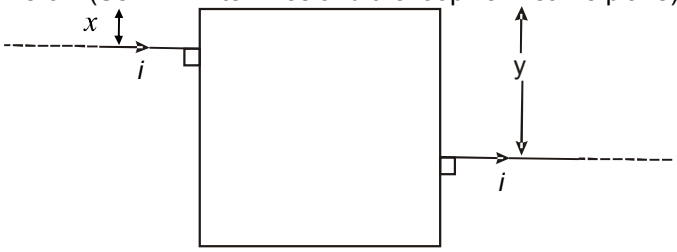


34. A and B are two infinite length wires carrying same magnitude current in opposite directions perpendicular to plane of paper as shown in figure. If magnetic field at point C is along A then 'θ' can be



(A) 30^0 (B) 45^0 (C) 60^0 (D) 15^0

35. A conducting square loop made of homogenous material and having uniform cross section of side 'a' is placed between two semi - infinite wires as shown in figure. Magnetic field intensity at centre of square loop is zero if (Semi-infinite wires and the loop lie in same plane)



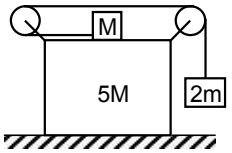
(A) x = 0 : y = 0 (B) x = 0 : y = a (C) x = $\frac{a}{2}$: y = $\frac{a}{2}$ (D) x = $\frac{a}{4}$: y = $\frac{3a}{4}$

SECTION-2 : (Integer value correct Type)

This section contains **5 questions.** The answer to each question is a **Two digit integer,** ranging from 00 to 99 (both inclusive).

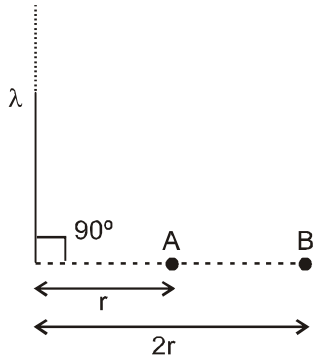
36. If in the system shown the initial acceleration of wedge of mass 5M is $\frac{xg}{17}$, then value of x is.

(pulley are ideal and the chords are inextensible and there is no frictional any where)

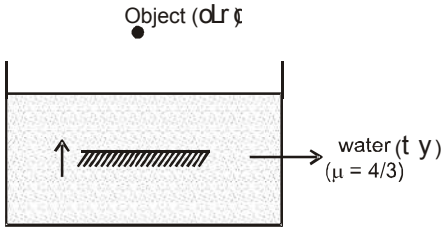


PHYSICS

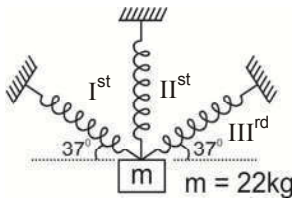
37. In the figure shown points A and B are at distance r and 2r respectively from one end of uniformly charged infinitely long wire having linear charge density λ. If potential difference $V_A - V_B$ is $\frac{\lambda}{16\pi\varepsilon_0}\ell n\, x$, calculate x.



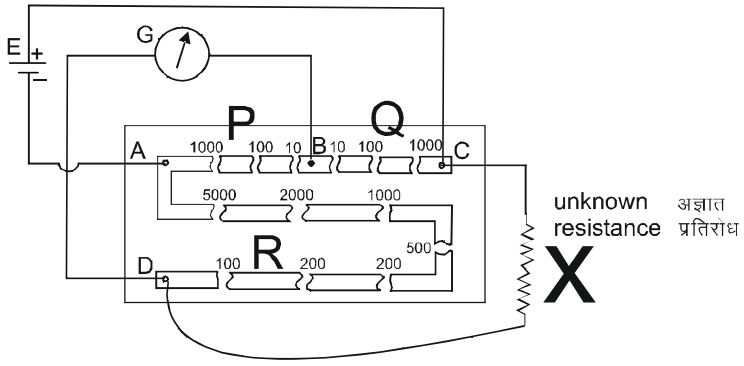
38. Mirror in the arrangement shown in figure is moving up with speed 8 cm/sec. Speed of final image (in cm/sec) is.



39. Initially system is in equilibrium such that extention in each spring is same and spring constant of each spring is k = 100 N/m. Acceleration of block just after I^{st} and III^{rd} spring are burnt simultaneously is $\frac{10n}{11}$ (in m/s^2). Value of n is ($g = 10\ m/s^2$)



40. In the figure shown below, the maximum possible unknown resistance (X), that can be measured by the post office box are X_{max} is given by $R \times 10^5\ \Omega$, then R is : (given that in this experiment, we can take out only one plug from arm AB and only one plug from arm BC, but from arm AD we can take out many plugs) :



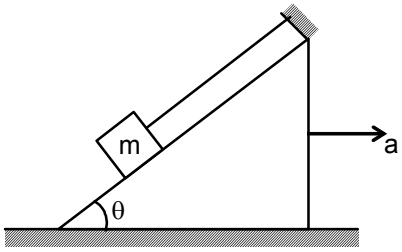
MOCKTEST -3

PHYSICS

SECTION-1 : (Only One option correct type)

This section contains **7 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

17. The wedge is moved towards right with acceleration a, which is slowly increased from zero. The tension in the string just when the small block of mass m breaks contact with the surface of wedge is (Assume all surfaces smooth, the string inextensible and neglect rotational effect's.)

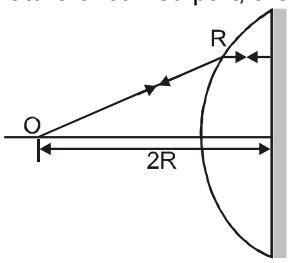


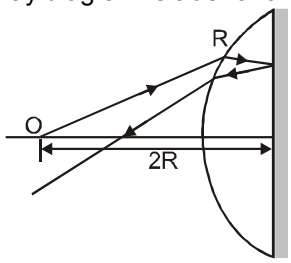
(A) mg sinθ (B) mg cosecθ (C) mg tanθ (D) mg cotθ

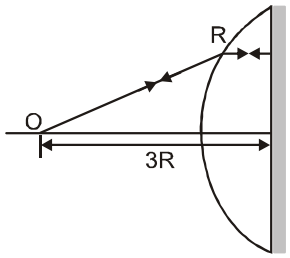
18. A particle is projected with a velocity v from the horizontal surface such that its range on the horizontal plane is twice the greatest height attained by it. The range of the projectile is (where g is acceleration due to gravity)

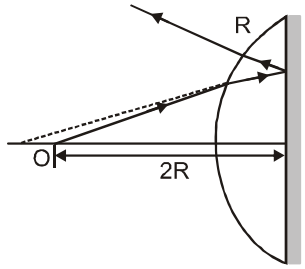
(A) $\frac{4v^2}{5g}$ (B) $\frac{3v^2}{5g}$ (C) $\frac{v^2}{g}$ (D) $\frac{4v^2}{\sqrt{5}g}$

19. A thin plano-convex glass lens (μ = 1.5) has its plane surface silvered and R is the radius of curvature of curved part, then which of the following ray diagram is true for an object placed at O ?

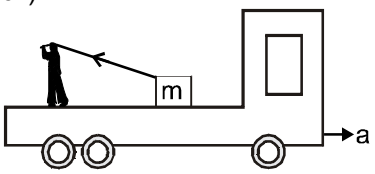
(A)


(B)


(C)


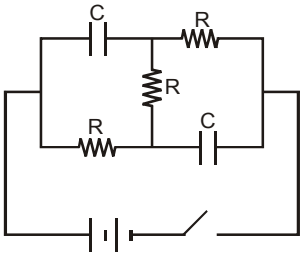
(D)


20. A crate of mass m is placed on a open rear truck which moves with an acceleration a. The minimum value of the tension T required to slide the crate on the open rear truck : (μ = coefficient of friction between crate & truck)



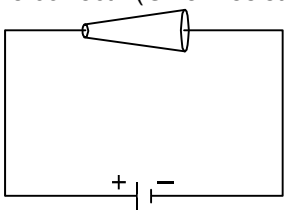
(A) $\frac{m(\mu g + a)}{\sqrt{1+\mu^2}}$ (B) $\frac{m(\mu g - a)}{\sqrt{1-\mu^2}}$ (C) $\frac{m(\mu g)}{\sqrt{1+\mu^2}}$ (D) $\frac{m(\mu g - a)}{\sqrt{1+\mu^2}}$

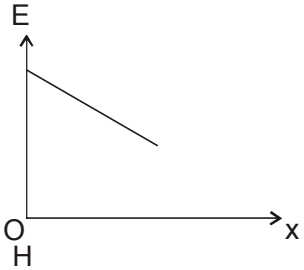
21. In given figure initially capacitors are uncharged, battery is ideal. Key is closed at t = 0, current through battery just after closing the key is I_1 and current through battery after long time is I_2. What is ratio $\frac{I_1}{I_2}$.

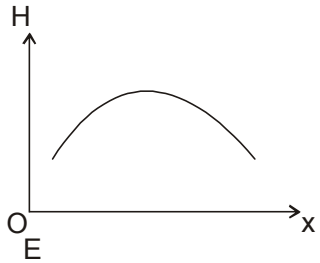


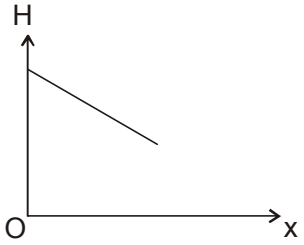
(A) 3 : 5 (B) 9 : 1 (C) 3 : 1 (D) 2 : 3

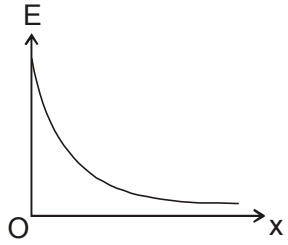
22. A battery of constant emf is connected across resistance as shown. If at a distance x from left end, electric field intensity and the rate of generation of heat per unit length are E and H respectively, which of the following graphs is/are correct? (Given resistivity of the resistance is uniform)



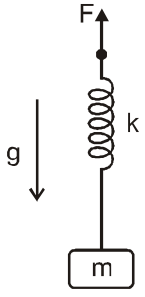
(A)


(B)


(C)


(D)


23. A block of mass m is connected to a spring (spring constant k). Initially the block is at rest and the spring is in its natural length. Now the system is released in uniform gravitational field as shown and a variable force F is applied on the upper end of the spring such that the downward acceleration of the block is given as $a = g - \alpha t$, where t is time elapsed and $\alpha = 1\ m/s^3$, the velocity of the point of application of the force is:



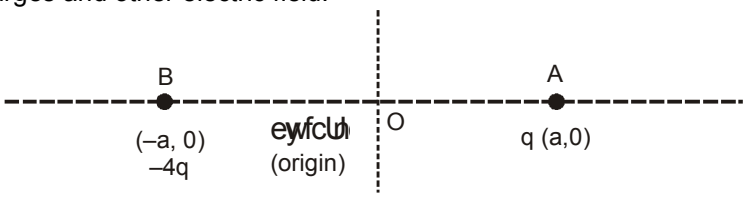
(A) $\frac{m}{k} - gt + \frac{t^2}{2}$ (B) $\frac{m}{k} + gt + \frac{t^2}{2}$ (C) $\frac{m}{k} - gt - \frac{t^2}{2}$ (D) $\frac{m}{k} - gt - t^2$

SECTION – 2 : (Paragraph Type)

This section contains **3 paragraphs** each describing theory, experiment, data etc**. Six questions** relate to three paragraphs with two questions on each paragraph. Each question of a paragraph has **only one correct answer** among the four choices (A), (B), (C) and (D).

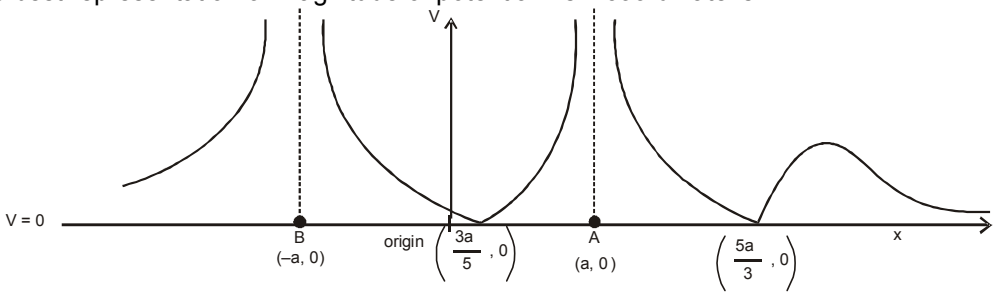
Paragraph for Questions 24 and 25

A system of two fixed charges A and B at the position (a, 0) and (–a, 0) is shown in figure. Assume that potential at the infinite distance, from the given system is zero, and system is isolated from any other charges and other electric field.

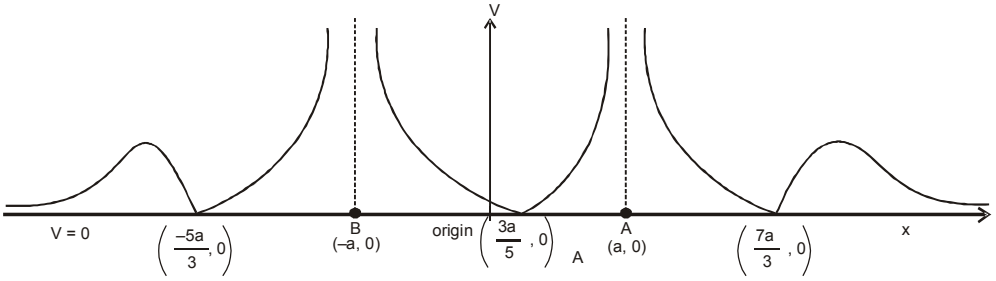


24. The best representation of magnitude of potential v/s x coordinate is :

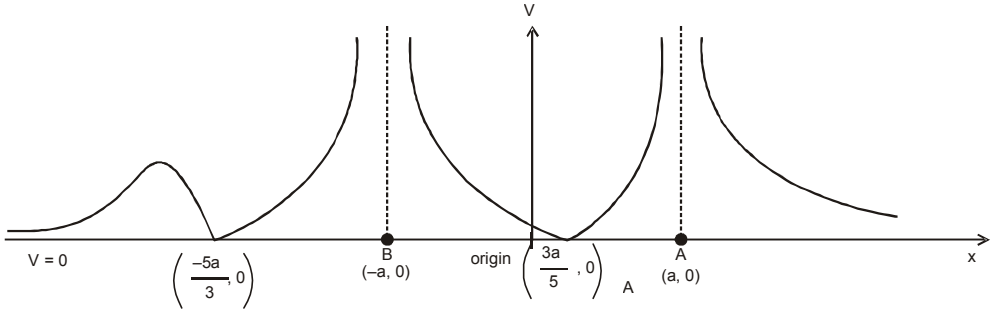
(A)



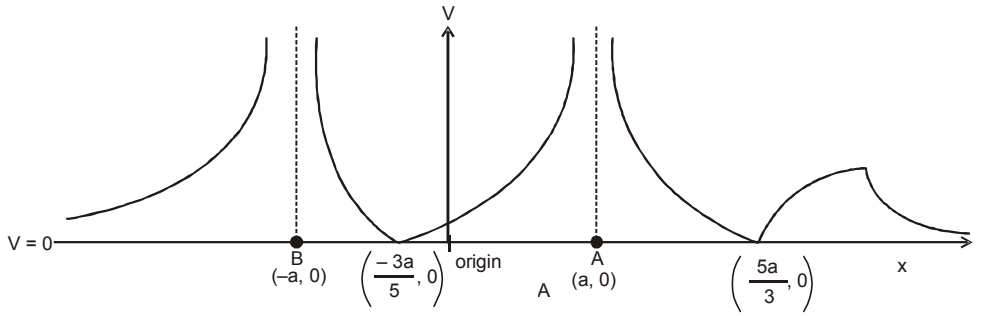
(B)



(C)



(D)



PHYSICS

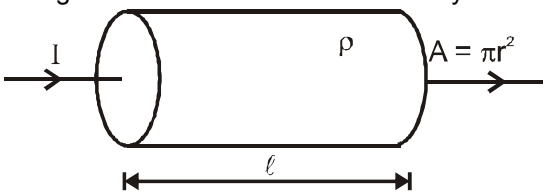
25. If charge particle of mass 'm' and having positive charge 'q_0' is projected from origin with $0.6\ v_0\ \hat{i} + 0.8\ v_0\ \hat{j}$ then the radius of curvature at the given instant :

(A) $\frac{4\pi\varepsilon_0 m(v_0 a)^2}{3qq_0}$ (B) $\frac{\pi\varepsilon_0 m(v_0 a_0)^2}{qq_0}$ (C) $\frac{64\pi\varepsilon_0 m(v_0 a)^2}{125qq_0}$ (D) Infinite

Paragraph for Questions 26 and 27

Suppose $\vec{E}$ and $\vec{B}$ are electric field and magnetic field at a point in space. The vector $\frac{\vec{E}\times\vec{B}}{\mu_0}$ is known as the poynting vector. The magnitude of poynting vector is the rate of flow of energy per unit area per unit time. The rate at which electromagnetic energy flows through any area is the flux of poynting vector through that area.

Consider a cylindrical conductor of length ℓ and radius of cross-section r. It carries I current distributed uniformly through out it's cross section. Resistivity of conductor is ρ.



26. What is magnitude of poynting vector at a point on lateral surface of the conductor ?

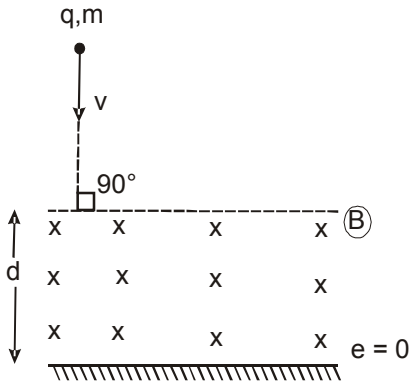
(A) $\frac{I\rho}{2\pi r^2}$ (B) $\frac{I^2\rho}{2\pi r^3}$ (C) $\frac{I^2\rho}{2\pi^2 r^2}$ (D) $\frac{I^2\rho}{2\pi^2 r^3}$

27. Total energy radiated per unit time through half cylindrical surface of the conductor is –

(A) $\frac{I^2\rho\ell}{\pi r^2}$ (B) $\frac{I^2\rho\ell}{\pi^2 r^2}$ (C) $\frac{I^2\rho\ell}{2\pi r^2}$ (D) Zero

Paragraph for Questions 28 and 29

A small ball of mass 'm' and charge 'q' in projected with velocity 'v' perpendicular to magnetic field . If $d = \frac{1}{2}\left(\frac{mv}{qB}\right)$ then : (neglect gravity & coefficient of restitution is zero)



28. Time spent by ball in magnetic field is

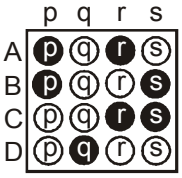
(A) $\frac{2\pi m}{3qB}$ (B) $\frac{3\pi m}{4qB}$ (C) $\frac{4\pi m}{3qB}$ (D) $\frac{3\pi m}{2qB}$

29. Displacement of ball between time spent in magnetic field.

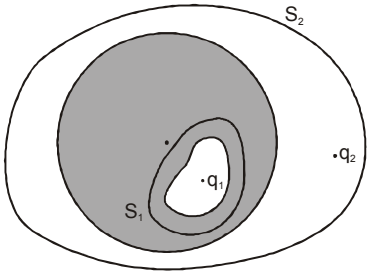
(A) $\frac{\left(3-\sqrt{3}\right)R}{2}$ (B) $\frac{\left(3-\sqrt{3}\right)R}{4}$ (C) $\left(3-\sqrt{3}\right)R$ (D) $\frac{\sqrt{3}R}{2}$

SECTION-3 : (Matrix - Match Type)

This section contains 3 questions. Each question contains statements given in two columns, which have to be matched. The statements in **Column-I** are labelled A, B, C and D, while the statements in **Column-II** are labelled p, q, r, s. Any given statement in **Column-I** can have correct matching with **ONE OR MORE** statement(s) in **Column-II**. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following example. If the correct matches are A-p, s and t ; B-q and r; C-p and q; and D-s; then the correct darkening of bubbles will look like the following :



30. Figure shows a conducting sphere (shaded portion) with a cavity. A point charge q_1, is placed inside cavity, and q_2 is placed out side the sphere. $\vec{E}_{in}$ is electric field due to charge induced on surface of cavity. $\vec{E}_{out}$ is electric field due to charge induced on outer surface of sphere and $\vec{E}_{net}$ is net field at any point. Two closed gaussian surface S_1 & S_2 are also drawn in the figure.



Column-I	**Column-II**
(A) $\int \vec{E}_{in}.\vec{da}$ for surface S_1	(p) $\frac{-q_1}{\varepsilon_0}$
(B) $\int \vec{E}_{out}.\vec{da}$ for surface S_2	(q) $\frac{q_1+q_2}{\varepsilon_0}$
(C) $\int \vec{E}_{net}.\vec{da}$ for surface S_1	(r) zero
(D) $\int \vec{E}_{net}.\vec{da}$ for surface S_2	(s) $\frac{q_1}{\varepsilon_0}$

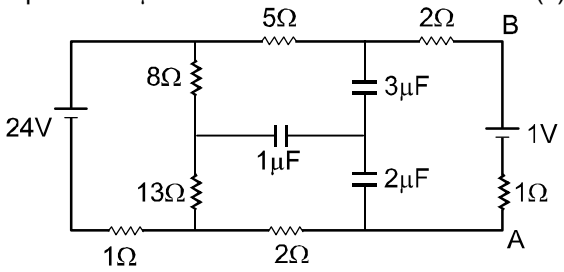
31. A satellite revolves around a planet, in a certain orbit of radius r_0. If V_0, K_0, T_0, P_0, E_0, B_0 and L_0 represent physical quantities as given below then match the entries of Column I & Column II for increasing radius of orbit.

V_0 – orbital velocity
T_0 – Time period
K_0 – Kinetic Energy of Satellite.
P_0 – Potential Energy of Satellite.
E_0 – Total Energy of Satellite.
B_0 – Binding Energy of Satellite
L_0 – Angular Momentum of Satellite about the centre of planet.

Column-I	**Column-II**
(A) V_0K_0	(p) Increase
(B) B_0L_0	(q) Decrease
(C) $P_0E_0L_0^4$	(r) Independent of r
(D) $\frac{T_0}{L_0^3}$	(s) Proportional to $r^{-3/2}$

32. In the circuit shown, consider all instants from initial (t = 0) state to steady (t = ∞) state. Initially the capacitors were uncharged.

Column–I	**Column–II**
(A) Charge on 3 μF capacitor in μC	(p) 2
(B) Current through 1V battery in ampere (Consider positive if it flows from A to B)	(q) 4
(C) potential difference across 2 μF capacitor in volt	(r) 6
(D) charge on 1μF capacitor in μC	(s) decreases with time



SECTION-1 : (One or more option correct type)

This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** are correct.

23. A proton is fired from origin with velocity $\vec{v} = v_0\hat{j} + v_0\hat{k}$ in a uniform magnetic field $\vec{B} = B_0\hat{j}$

In the subsequent motion of the proton

(A) its z-coordinate can never be negative

(B) its x-coordinate can never be positive

(C) its x-and z-coordinates cannot be zero at the same time

(D) its y-coordinate will be proportional to its time of flight

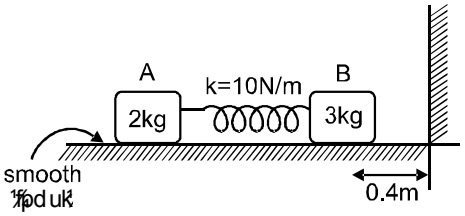
24. Initially distance between two small blocks A and B is 1m and natural length of spring is 2m. Now the system is released. If B hits the vertical wall elastically then : (All surfaces are smooth)

(A) Maximum extension in spring during complete motion is 20cm.

(B) Maximum speed of block B during complete motion is $\frac{2}{\sqrt{3}}$ m/sec.

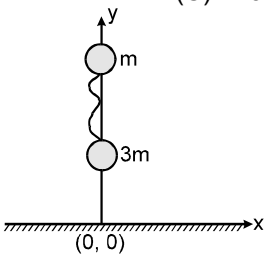
(C) At maximum extension speed of block A is $\frac{4\sqrt{3}}{5}$ m/sec.

(D) Impulse by vertical wall on block B is $4\sqrt{3}$ N.sec.



25. A coordinate axis system taking x-axis as horizontal smooth floor is shown in figure. Two small balls of masses m and 3m attached with a string are released from some heights on y-axis as shown in figure. The balls may collide head on or obliquely. After a certain time mass m is at (9 cm, 20 cm) while mass 3m is 25 cm above the x axis and the strings is taut. The balls always remain in x-y plane. The length of string is.

(A) 13cm (B) 15cm (C) 12cm (D) None of these



26. The circuit shown is in steady state

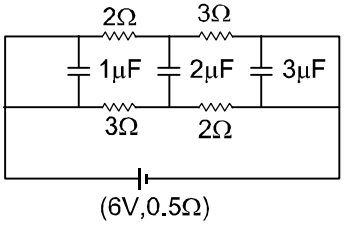
Choose the correct options :

(A) charge on 1μF capacitor is same as charge on 3 μF capacitor

(B) charge on 2μF capacitor is 2 μC

(C) current through the battery is 2A

(D) current is same in each external resistance



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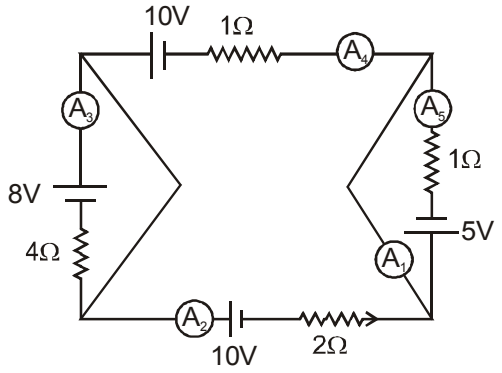
27. In the given circuit all ammeters are ideal. Then choose correct statement.

(A) Reading of A_2 = Reading of A_5.

(B) Reading of A_2 and Reading of A_4 both are zero.

(C) Reading of A_1 is 5 amp

(D) Reading of $A_1 = \frac{5}{2}$ times reading of A_3.



28. A particle moving with constant speed u inside a fixed smooth hemispherical bowl of radius a describes a horizontal circle at a distance $\frac{a}{2}$ below its centre. Then

(A) The radius of the circular motion is $\frac{a\sqrt{3}}{2}$

(B) The value of u is $\sqrt{\frac{3ag}{2}}$

(C) The normal reaction of the spherical surface on the particle is $\frac{mg}{2}$

(D) The magnitude of the resultant force acting on the particle is zero, in an inertial frame.

29. Which of the folloiwng statements is/are correct ?

(A) If a moving charged particle enters into a region of magnetic field from outside, it does not complete a circular path.

(B) If a moving charged particle traces a helical path in a uniform magnetic field, the axis of the helix is parallel to the magnetic field.

(C) The power associated with the force exerted by a magnetic field on a moving charged particle is always equal to zero.

(D) If in a region a uniform magnetic field and a uniform electric field both exist, a charged particle moving in this region cannot trace a circular path.

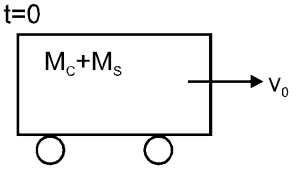
30. A railway carriage of mass M_c filled with sand of mass M_s moves along the rails. The carriage is given an impulse and it starts with a velocity v_0. At the same time it is observed that the sand starts leaking through a hole at the bottom of the carriage at a constant mass rate λ. Choose the correct alternative(s). (Neglect the friction along the rails.)

(A) The distance at which the carriage becomes empty is $V_0 \frac{M_s}{\lambda}$.

(B) The velocity attained by the carriage at the time, when the carriage becomes empty is v_0.

(C) The time at which the carriage becomes empty is $\frac{M_s}{\lambda}$.

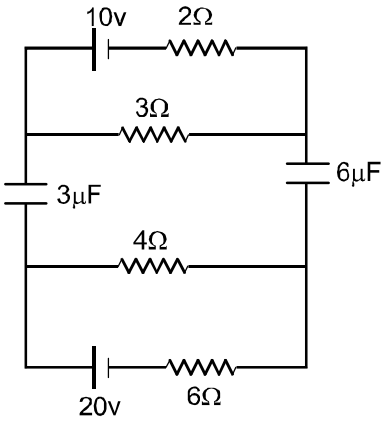
(D) None of these is correct.



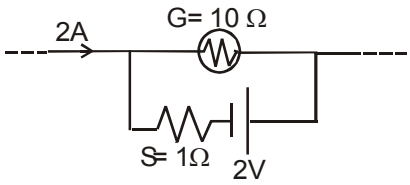
SECTION-2 : (Integer value correct Type)

This section contains **14 questions**. The answer to each question is a **single digit integer,** ranging from 0 to 9 (both inclusive)

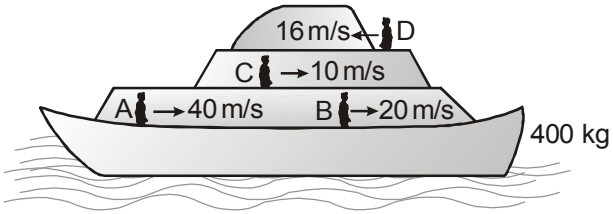
31. In the circuit shown in the figure. The steady state charge on 6μF capacitor is qμC. Find the value of q :



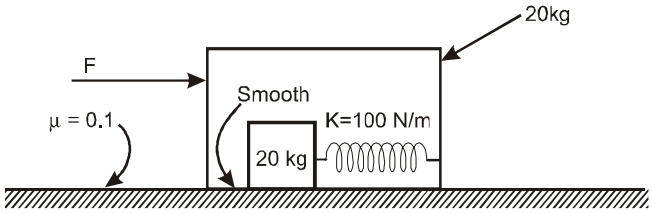
32. The galvanometer shown in the figure has resistance 10Ω .It is shunted by a series combination of a resistance S = 1Ω and an ideal cell of emf 2V. A current 2A passes as shown. The potential difference (in volts) across the resistance S is



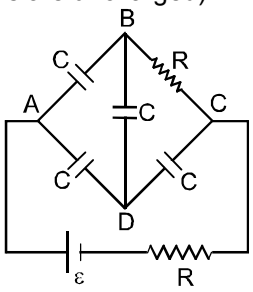
33. Figure shows a Yacht of mass 400 kg with three decks. When the engine of Yacht is off, four men A, B, C and D (m_A = 100 kg, m_B = 120 kg, m_C = 80 kg and m_D = 100 kg) started running on different decks with constant horizontal velocities relative to yacht which are marked in figure. All the velocity vectors are collinear. Due to this, Yacht also started moving. What is the speed in m/s with which Yacht moves.



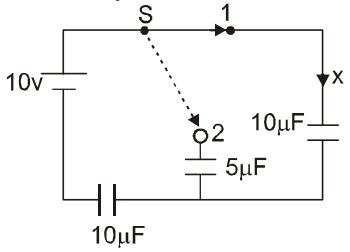
34. A box of mass 20 kg is kept on a rough horizontal surface (μ = 0.1). There is a spring mass system having block of mass 20 kg and spring of spring constant 100 N/m in the box. There is no friction between block and box and spring is initially relaxed. Now an external force of 120 N is applied on the box, find acceleration of the box (in m/s^2) just after applying the force.



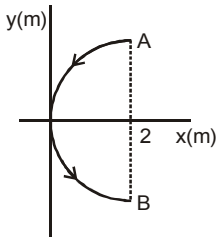
35. In the circuit shown, charge on the capacitor connected between B and D at steady state is $\frac{C\varepsilon}{x}$. then find x (initially all the capacitors are uncharged)



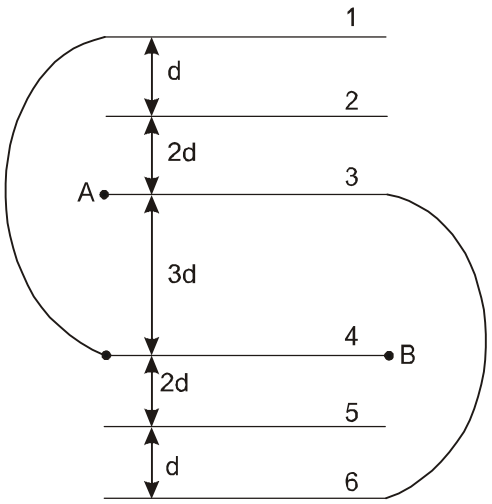
36. Initially S is connected to 1 as shown in the figure and then S is also connected to 2 using another connecting wire. Due to 2nd connection some redistribution of charge occurs in the circuit. For this situation, the thermal energy (in micro joules) dissipiated in the circuit after the second connection is made is 10x, find x. (Initially before any connections all the capacitors were uncharged)



37. A conducting wire bent in the form of a parabola $y^2 = 2x$ carries a current i = 2 A as shown in figure. This wire is placed in a uniform magnetic field $\vec{B} = 4\hat{k}$ Tesla. The magnitude of magnetic force on the wire is 4x (in newton). Find x.

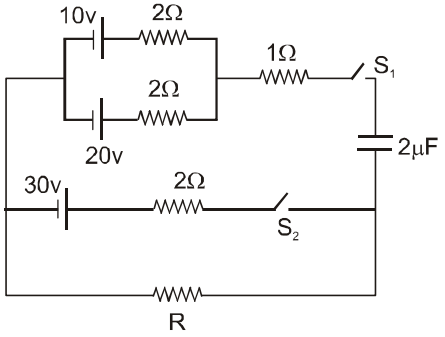


38. There are six plates of equal area A and the plates are arranged as shown in the figure. The equivalent capacitance between A and B is $\frac{N\varepsilon_0 A}{d}$, find N.

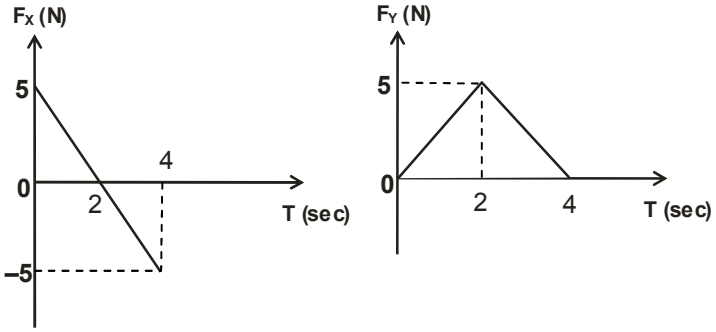


PHYSICS

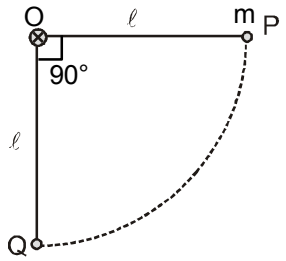
39. Some ideal batteries, an unknown resistance and a capacitor are connected as shown in the circuit. At t = 0, current in R is 1 amp towards left. The value of R (in Ω) is $\frac{86}{x}$, find x. (S_1 and S_2 are closed at t = 0)



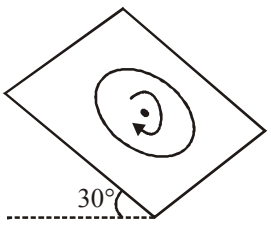
40. The particle of mass 1 kg is acted upon by a force $\vec{F} = F_x\hat{i} + F_y\hat{j}$ for time t = 4 sec starting from t = 0. The speed of the particle at t = 4 sec., if its initial velocity is $\vec{u} = -\hat{i} + \hat{j}$ and the variation of applied force with time is as shown in the graphs, is $\sqrt{61x}$ m/s, find x



41. The bob of mass m is attached to the massless string of length ℓ. It is released when the string is horizontal & bob is at point P. The net acceleration of the bob when it reaches point Q is 4x m/s^2, find x (the axis passing through point O is horizontal and the mass moves in vertical plane., take g = 10m/s^2)



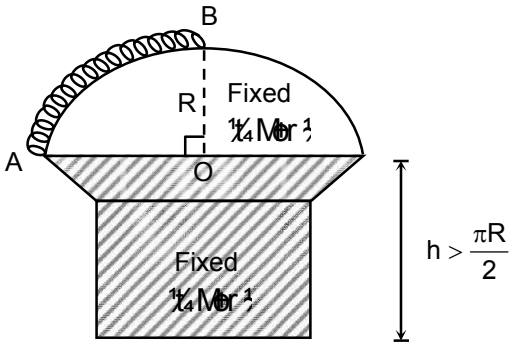
42. An old record player of 10 cm radius turns at 10 rad/s while mounted on a 30° incline as shown in the figure. A particle of mass m can be placed any where on the rotating record. If the least possible coefficient of friction μ that must exist for no slipping to occur any where is μ, find the value of $2\sqrt{3}\,\mu$.



PHYSICS

43. A particle moves with constant speed along a circle. The magnitudes of average acceleration in covering an angle θ is a_1 and in covering an angle $2\pi + \theta$ is a_2. If $\frac{a_1}{a_2} = 4$ then $\frac{\theta}{20}$ (in degrees) will be :

44. A uniform chain of mass M and length L = $\frac{\pi R}{2}$ is kept on a smooth fixed hemisphere of radius R as shown. It is released from the shown position from rest. The kinetic energy of the chain at the instant the complete chain just leaves the hemisphere is 2Mgx. find x, (Take R = 4π and $\pi^2 = 10$)



(Only One option correct type)

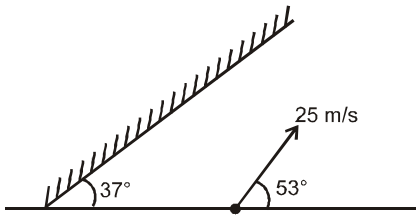
This section contains **25 multiple choice questions**. Each question has five choices (A), (B), (C), (D) and (E) out of which **ONLY ONE** is correct.

26. A planet is revolving in an elliptical orbit around sun, fixed at the focus of ellipse. The minimum and maximum distance of planet from sun are r_1 and r_2 respectively. The minimum distance of planet from centre of ellipse is :

(A) $\frac{r_1+r_2}{2}$ (B) $\frac{2r_1r_2}{r_1+r_2}$ (C) $\frac{r_1r_2}{r_1+r_2}$ (D) $\frac{r_1-r_2}{2}$

(E) $\sqrt{r_1r_2}$

27. A particle is projected with speed 25 m/s at angle 53° from horizontal in front of an inclined plane mirror as shown in figure. After how much time speed of image w.r.t. object will be minimum ($g = 10\ m/s^2$)



(A) $\frac{7}{8}$s (B) $\frac{5}{3}$s (C) $\frac{4}{5}$s (D) 1s

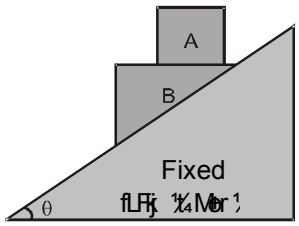
(E) $\frac{3}{5}$s

28. A point source S is placed at distance 40 cm from a screen. Intensity at a point P on screen which is closest to the source is I_0. A convex lens of focal length 20 cm is placed exactly at mid-point of SP such that SP is principal axis of the convex lens. Now intensity at P becomes:

(A) $2I_0$ (B) $3I_0$ (C) $4I_0$ (D) $5I_0$

(E) $6I_0$

29. The coefficient of friction between the block A of mass m and wedge B of mass 2m is $\mu = \frac{1}{\sqrt{3}}$. The inclined plane is smooth. If the system of blocks A and B is released from rest and there is no slipping between A and B, then $\theta \le \frac{\pi}{\alpha}$. Find the value of α.

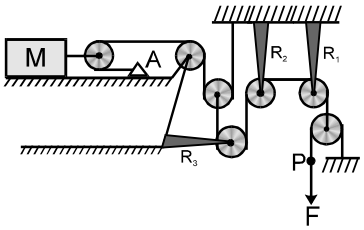


(A) α =5 (B) α = 3 (C) α = 4 (D) α = 8

(E) α = 6

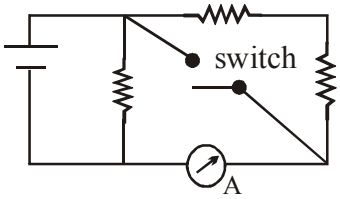
PHYSICS

30. In the given arrangement, mass of the block is M and the surface on which the block is placed is smooth. Assuming all pulleys to be massless and frictionless, strings to be inelastic and light, R_1, R_2 and R_3 to be light supporting rods, then acceleration of point 'P' will be (A is fixed) :



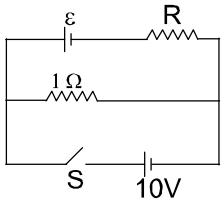
(A) 0 (B) ∞ (C) $\frac{4F}{m}$ (D) $\frac{2F}{m}$ (E) $\frac{F}{2m}$

31. In the circuit shown, the reading of the Ammeter is doubled after the switch is closed. Each resistor has a resistance = 1 Ω and the ideal cell has an e.m.f. = 10 V. Then the ammeter has a resistance equal to



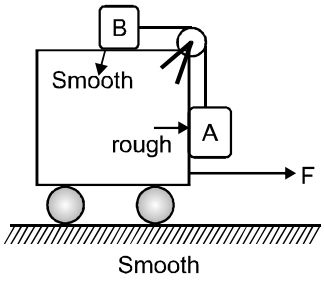
(A) 3 Ω (B) 1 Ω (C) 2.5 Ω (D) 5 Ω
(E) 2 Ω

32. The power dissipated in resistor R is 16R watt, whether the switch S is closed or open. The unknown e.m.f. ε in the circuit is
(A) 4V (B) 6V (C) 7V (D) 9V
(E) None of these



33. A boat is rowed across a river at the rate of 4.5 km/hr. The river flows at the rate of 6 km/hr. The velocity of boat in m/s is approximately :
(A) 3.1 (B) 2.1 (C) 2.9 (D) 5
(E) None of these

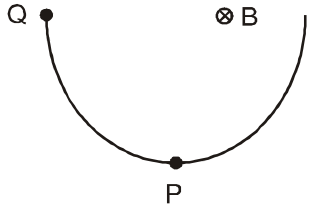
34. On a cart of mass 3 m, two blocks A and B, each of mass m are placed are placed as shown. Upper surface of the cart is smooth, but the vertical surface is rough having friction coefficient μ = 0.5. The cart is pulled with a constant force F. What should be the value of F so that neither static, nor kinetic friction acts on block A.



(A) 5 mg (B) $\frac{5}{2}$mg (C) 7 mg (D) 10 mg
(E) mg

PHYSICS

35. A charge particle of mass 'm' & charge –q is released from rest from a given position Q inside a fixed vertical semicircular trough. For the presence and the absence of magnetic field normal reaction acting on the charge at P are N_1 & N_2 respectively. Neglecting friction & assuming gravity presence. The value of $N_1 - N_2$ is :



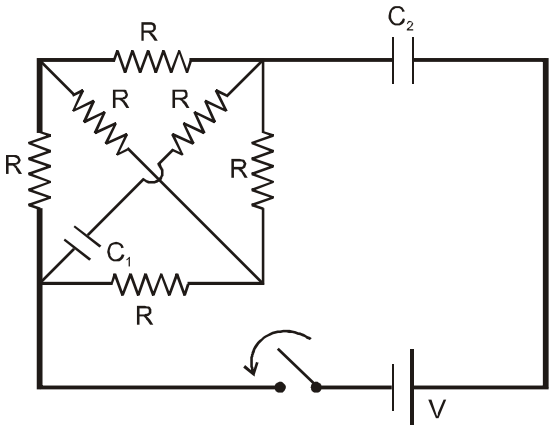
(A) $2Bq\sqrt{2gR}$ (B) $\frac{Bq\sqrt{2gR}}{2}$ (C) $Bq\sqrt{2gR}$ (D) $\frac{Bq\sqrt{2gR}}{4}$

(E) $Bq\sqrt{3gR}$

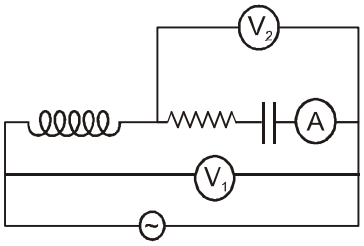
36. For the circuit shown in figure, switch is closed at t = 0 find ratio of charge on capacitor C_1 to capacitor C_2 at steady state.

(A) 1 : 2 (B) 3 : 5 (C) 4 : 2 (D) 1 : 1

(E) None of these



37. In the ac circuit shown, X_L= 7 Ω, R = 4 Ω and X_C=4 Ω.The reading of the ideal voltmeter V_2 is $8\sqrt{2}$. Then the reading of the ideal ammeter will be:



(A) 1 A (B) $2\sqrt{2}$ A (C) $\sqrt{2}$ A (D) $\frac{1}{\sqrt{2}}$ A

(E) 2A

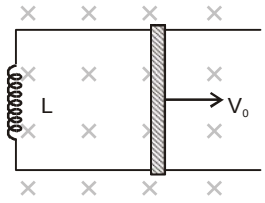
38. A particle is projected from ground at some angle to the horizontal. (Assuming point of projection to be origin and the horizontal and vertical directions to be the x & y axis) the particle passes through the points (3, 4) and (4, 3) during its motion. The horizontal range of the particle is :

(A) $\frac{37}{7}$ m (B) $\frac{50}{23}$ m (C) $\frac{4}{3}$ m (D) $\frac{3}{4}$ m

(E) 2.5 m

PHYSICS

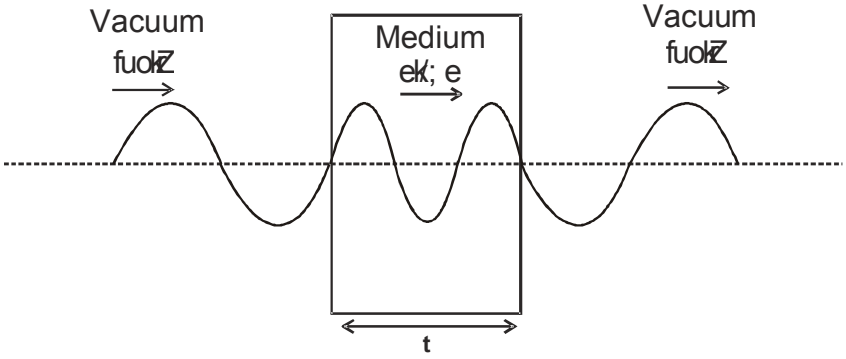
39. A conducting bar of mass m and ℓ is free to slide on two smooth and fixed horizontal conducting rail. Then ends of rail are connected through a coil of self inductance L. There exist a uniform and constant inward magnetic field B. If the conducting bar of mass 'm' is projected with velocity V_0, towards right. Then find distance covered by bar before it stops. (Assume no resistance anywhere in the circuit)



(A) $2\frac{\sqrt{mL}}{B\ell}V_0$ (B) $\frac{\sqrt{mL}}{4B\ell}V_0$ (C) $\frac{\sqrt{mL}}{3B\ell}V_0$ (D) $\frac{\sqrt{mL}}{\sqrt{2}B\ell}V_0$

(E) $\frac{\sqrt{mL}}{B\ell}V_0$

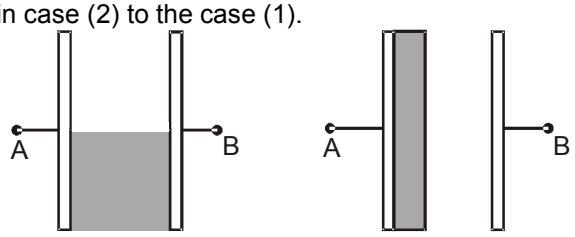
40. In given figure, a light wave travels through a transparent slab of thickness t = λ as shown, refractive index of the slab is 'μ', where 'λ' is wavelength of light in vacuum.



(A) $\mu = 1$ (B) $\mu = \frac{4}{3}$ (C) $\mu = \frac{3}{2}$ (D) $\mu = \frac{5}{4}$

(E) $\mu = 2$

41. Two identical parallel plate capacitors are filled with same dielectric material (dielectric constant K = 2) in two different ways as shown in figure. In first case the parallel plate capacitor is half filled. In both cases capacitance between A and B is same. The ratio of volume of dielectric material between two plates in case (2) to the case (1).



Case (1) Case (2)

(A) $\frac{5}{4}$ (B) $\frac{2}{5}$ (C) $\frac{1}{4}$ (D) $\frac{2}{3}$

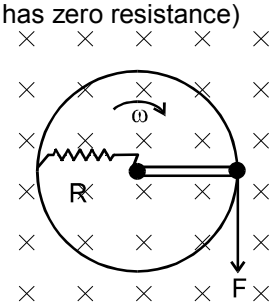
(E) $\frac{4}{3}$

PHYSICS

42. The resistance of three wires BC, CA and AB of same uniform cross–section and material are a, b and c respectively in ohms. Another wire from A of resistance d = 5Ω can make a sliding contact with BC. A battery of constant emf ε = 4V is connected between A and point of contact with BC. Further it is known that value of d is equal to sum of the three resistance a, b and c. The minimum current drawn from the battery is i_0 in amperes. Find the value of i_0 .

(A) 1 (B) 2 (C) 4 (D) 3
(E) 5

43. A metallic ring of mass 2 kg and radius 1m with a uniform metallic spoke of same mass 2kg and length 1 m is rotated about its axis with angular velocity 1 rev/sec. in a perpendicular uniform magnetic field B of magnitude 10T as shown if figure. If the central end of the spoke is connected to the rim of the wheel through a resistor R of magnitude $\pi\,\Omega$ as shown. The resistor does not rotate, its one end is always at the center of the ring and other end is always in contact with the ring. A force F as shown is needed to maintain constant angular velocity of the spoke then, F is equal to (The ring and the spoke has zero resistance)

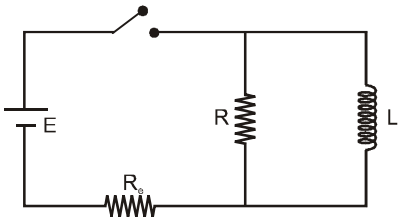


(A) 10 N (B) 20 N (C) 50 N (D) 30 N
(E) 25 N

44. A source of alternating emf $E = E_0 \sin\omega t$ is connected in series with a capacitor and inductor in a circuit with neglisble resistance. Natural frequency of LC oscillation is $\omega_0 = \frac{1}{\sqrt{LC}}$. If charge on capacitor at any moment is given by :
$Q = Q_0 \sin\omega t$ then magnitude of Q_0 is :

(A) $\frac{E_0}{|\omega^2 - \omega_0^2|}$ (B) $\frac{E_0}{L\omega^2}$ (C) $\frac{E_0}{L|\omega^2 - \omega_0^2|}$ (D) $\frac{E_0 C}{\omega_0^2}$
(E) None of these

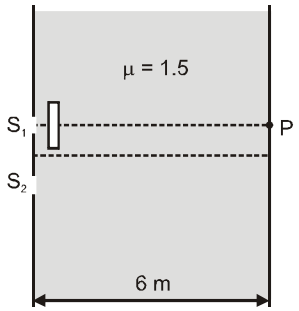
45. In the given circuit Key is closed at t = 0. At what time the P.D across inductor is one fourth of emf of the cell.



(A) $\frac{L}{R}\ell n2$ (B) $\frac{L}{R}\ell n4$ (C) 0 (D) $\frac{2L}{R}$
(E) $\frac{L}{2R}\ell n2$

PHYSICS

46. Light of wavelength λ is incident normally on a plane containg two slits separated by distance 2mm. The interference is observed on a screen 6m away from slits. Space between plane and screen has a uniform refractive index 1.5. A thin vacuum film of thickness 0.2 μm is created in front of the slit S_1. What is maximum wavelength (in vacuum) for which a maxima is observed at P exactly in front of the slit S_1.



(A) 4000Å (B) 5500Å (C) 6000Å (D) 6500Å
(E) 5000Å

47. An electric current i enters and leaves a uniform circular wire of radius a through diametrically opposite points. A charged particle q moving along the axis of the circular wire passes through its centre at speed υ. The magnetic force acting on the particle when it passes through the centre has a magnitude

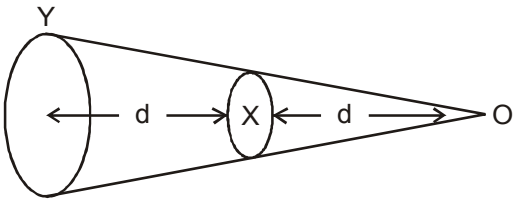
(A) $q\upsilon\frac{\mu_0 i}{2a}$ (B) $q\upsilon\frac{\mu_0 i}{2\pi a}$ (C) $q\upsilon\frac{\mu_0 i}{a}$ (D) zero
(E) None of these

48. An AC source is rated 220 V, 50 Hz. The average voltage is calculated in a time interval of 0.01 s. It

(A) must be zero (B) may be zero
(C) is never zero (D) is $(2\left(\frac{220}{\sqrt{2}}\right)V$
(E) is $\left(\frac{220}{\pi}\right)V$

49. Two circular coils X and Y having equal number of turns and carry equal currents in the same sense and subtend same solid angle at point O. If the smaller coil X is midway be between O and Y, then if we represent the magnetic induction due to bigger coil Y at O as B_y and that due to smaller coil X at O as B_x, then

(A) $\frac{B_y}{B_x}=1$ (B) $\frac{B_y}{B_x}=2$ (C) $\frac{B_y}{B_x}=\frac{1}{2}$ (D) $\frac{B_y}{B_x}=\frac{1}{4}$
(E) None of these



50. To reduce the light reflected by the glass surface of a camera lens, the surface is coated with a thin layer of another material which has an index of refraction (μ = 7/4) smaller than that of glass. The least thickness of the layer, to ensure that light falling perpendicularly on the surface and having wavelengths, λ_1 = 700nm and λ_2 = 420nm will be weekly reflected for both wavelengths

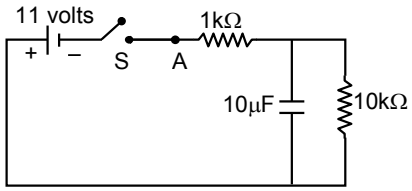
(A) 200 nm (B) 300 nm (C) 400 nm (D) 500 nm
(E) 600 nm

SECTION-1 : (One or more option correct type)

This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** are correct.

23. If one of the slit in a standard YDSE apparatus is covered by a thin glass slab so that it transmits only one half of the light intensity of the other. Select correct alternatives :
(A) Resultant intensity at centre of screen will decrease
(B) Resultant intensity at dark fringe will increase
(C) The fringe width will remain unchanged
(D) The fringe pattern will shift toward the covered slit.

24. In the circuit shown, when the switch 'S' is closed at t = 0 then for the current in the circuit and charge on the capacitor, one can say ;
(A) At t = 0, I = 11 mA and with time it goes to zero
(B) At t = ∞, I = 1mA and charge on the capacitor is 10^{-4} C
(C) At t = 0, I = 11 mA and with time it goes to 1 mA
(D) At t = ∞, I = 11 mA and charge on the capacitor is 10^{-4}C



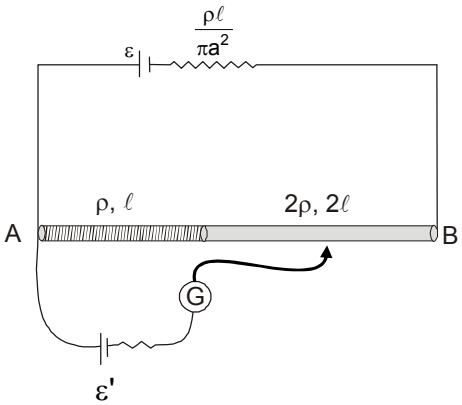
25. Two concentric metallic shell's of radius R and 2R, out of which the inner shell is having charge Q and outer shell is uncharged. If they are connected with a conducting wire. Then,
(A) Q amount of charge will flow from inner to outer shell.
(B) Q/e number of electrons will flow from inner to outer shell, where e is charge of electron.
(C) $\frac{KQ^2}{8R}$ amount of heat is produced in the wire
(D) $\frac{KQ^2}{4R}$ amount of heat is produced in the wire.

26. In a potentiometer primary cell has internal resistance of $\frac{\rho\ell}{\pi a^2}$ as shown in figure. The potentiometer wire is combination of two wires connected in series as shown in figure. The common cross sectional radius of both wires used for potentiometer is 'a'.

(A) Range of potentiometer is $\frac{5\varepsilon}{6}$ (B) Range of potentiometer is $\frac{2\varepsilon}{3}$

(C) If null point is at mid point of longer wire then $\varepsilon' = \frac{\varepsilon}{2}$

(D) If null point is at mid point of longer wire then $\varepsilon' = \frac{\varepsilon}{4}$



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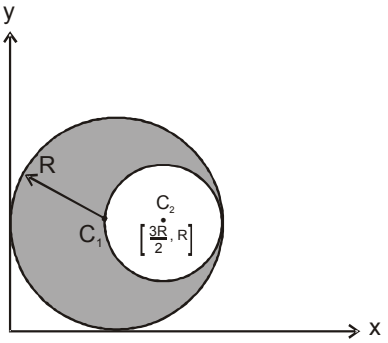
27. There is a fixed uniform solid sphere of mass density 'ρ' with a cavity of radius $\frac{R}{2}$ as shown in figure. Centre of sphere is C_1 & cavity is C_2. A point mass is placed at centre of cavity & released. Neglect the effect of gravity of earth. Then choose the correct options :

(A) point mass hit the cavity surface at y < R

(B) time taken to hit the cavity surface will be independent of radius R.

(C) velocity just before hitting the cavity surface will be $R\sqrt{\frac{2\pi}{3}G\rho}$.

(D) acceleration of point mass will be proportional to radius R.



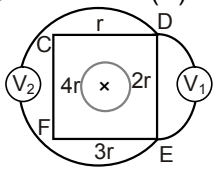
28. Four uniform wires have equal length 1 m each and resistance in the ratio 1 : 2 : 3 : 4 are connected together to form a square CDEF in that order i.e. CD, DE, EF, FC and resistance of wire CD is 'r'. This loop surrounds a uniform magnetic field whose net flux depends on time according to relation ϕ = 40t Weber, where 't' is in second. The field is perpendicular to the plane of loop. (V_1 & V_2 are ideal voltmeters)

(A) Current in the loop is $\frac{4}{r}$

(B) Reading of voltmeters V_1 and V_2 are equal

(C) Reading of voltmeter V_1 is 8 volt

(D) Reading of voltmeter V_2 is 8 volt



29. An AC source rated 100 V (rms) supplies a current of 10 A (rms) to a circuit. The average power delivered by the source

(A) must be 1000 W

(B) may be 1000 W

(C) may be greater than 1000 W

(D) may be less than 1000 W

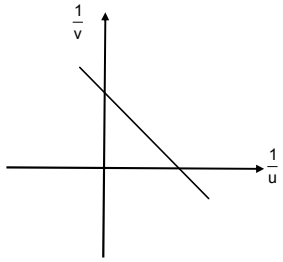
30. Select correct curve for convex mirror :

u = position of object

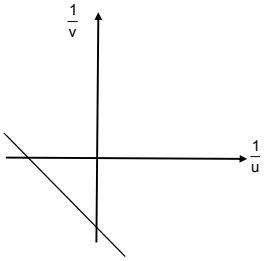
v = position of image

m = transverse magnification

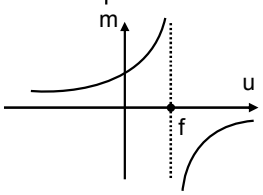
(A)



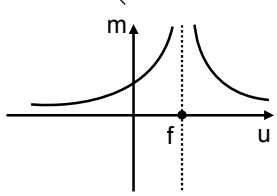
(B)



(C)



(D)



SECTION – 2 : (Paragraph Type)

This section contains **3 paragraphs** each describing theory, experiment, data etc**. Six questions** relate to three paragraphs with two questions on each paragraph. Each question of a paragraph has **only one correct answer** among the four choices (A), (B), (C) and (D).

Paragraph for Questions 31 and 32

Two particles of equal masses are simultaneously projected in a vertical (x-y) plane. The gravity (g = 10 m/s^2) is along negative y-direction. The particle A is projected from origin of the x-y coordinate system, with a speed of $40\sqrt{2}$ m/s at an angle of θ with the horizontal (positive x-axis along ground) direction. The particle B is horizontally projected along positive x-direction with a speed of 40 m/s, from the coordinate (0, 120 m). Then answer the following questions.

31. If the two particles collides, find time instant at which the two particles will collides in air.

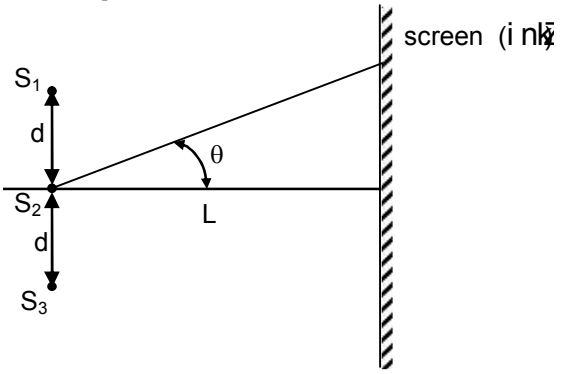
(A) $\frac{5}{\sqrt{2}}$ sec (B) 3 sec (C) 5 sec (D) 4 sec

32. Find the coordinates of particles at the instant of collision in air ?

(A) (120 m, 120 m) (B) (120 m, 75 m) (C) (75 m, 30 m) (D) None of these

Paragraph for Questions 33 and 34

Given three radio sources of equal intensity and phase. The original frequency is 10^6 Hz. We observe the interference pattern on a screen a distance L from the sources, and find that the distance between two adjacent maxima is 10 km. The distance between adjacent sources is d = 1 km. (Assume that L >> d]



33. What is the distance L ?

(A) $\frac{100}{3}$km (B) $\frac{200}{3}$km (C) $\frac{50}{3}$km (D) None of these

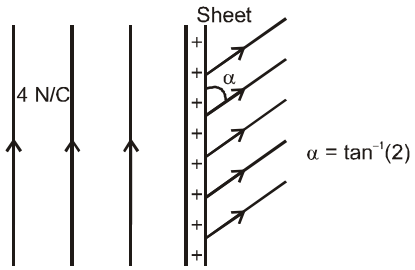
34. The central source stops, and the two other sources are moved in such way that the maxima points are unchanged (while preserving the symmetry.) What is the new distance between the two sources ?

(A) 1 km (B) $\frac{1}{2}$ km (C) $\frac{2}{3}$ km (D) None of these

Paragraph for Questions 35 and 36

An Infinite large uniform charged non-conducting sheet having surface charge density σ is placed in an external uniform electric field $\vec{E}$. Figure shows electric field lines near the sheet. Magnitude of electric field in left side of sheet is 4N/C and electric field in right side of the sheet is at angle $\tan^{-1}(2)$ from sheet.

PHYSICS



35. What is magnitude of uniform external electric field ?

(A) 4 N/C (B) 5 N/C (C) $2\sqrt{2}$ N/C (D) $4\sqrt{2}$ N/C

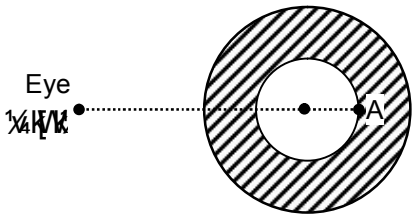
36. If $\vec{E}_L$ is electric field in region left side of the sheet and $\vec{E}_R$ is electric field in region right side of the sheet then which of the following is correct statement :

(A) $|\vec{E}_L - \vec{E}_R| = \frac{\sigma}{2\varepsilon_0}$ (B) $|\vec{E}_L - \vec{E}_R| = \frac{\sigma}{\varepsilon_0}$ (C) $|\vec{E}_L - \vec{E}_R| = \frac{2\sigma}{\varepsilon_0}$ (D) $|\vec{E}_L - \vec{E}_R| = \frac{\sigma^2}{2\varepsilon_0}$

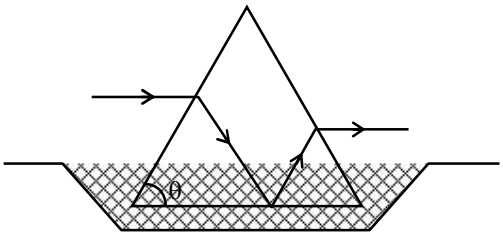
SECTION-3 : (Integer value correct Type)

This section contains **8 questions**. The answer to each question is a **single digit integer,** ranging from 0 to 9 (both inclusive)

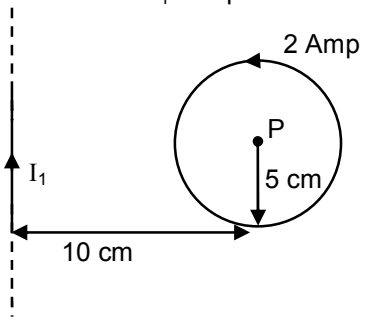
37. The figure here shows a glass ball of refractive index 1.5 having inner radius 7 cm and outer radius 14 cm. The ball has a small mark at point A on its inner surface. This mark is being observerd by an eye as shown. How nearer/farther than it really is will the mark appear to the eye (Answer should be in cm)



38. An isosceles triangular glass prism stands with its base in water as shown. A ray is incident parallel to base of prism. After refraction through inclined face it just suffers total internal reflection on water glass interface. If value of tanθ is $\frac{\lambda}{\sqrt{17}}$ then find λ. (Take μ_{glass} = 3/2, μ_{water} = 4/3)

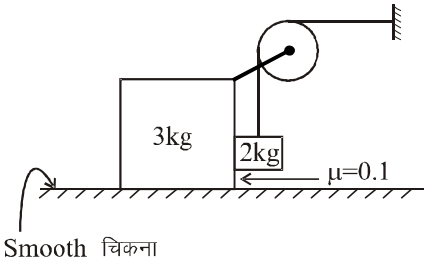


39. Magnetic field at point P is zero. If current I_1 is equal to Xπ A. Then Find the value of X.



40. An earth satellite is revolving in a circular orbit of radius a with a velocity v_0. A gun in the satellite is directly aimed toward earth. A bullet is fired from the gun with muzzle velocity $\frac{v_0}{2}$. Find the ratio of distance of farthest and closest approach of bullet from centre of earth. (Assume that mass of the satellite is very-very large with respect to the mass of the bullet)

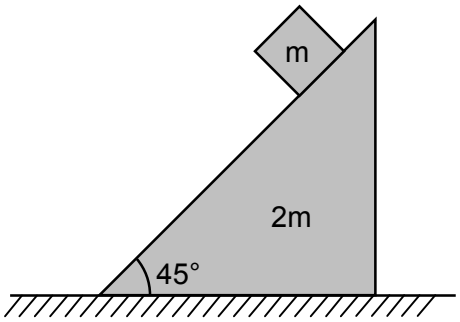
41. System shown in figure is released from rest. Then the acceleration of 2kg block is $\frac{25\sqrt{2}}{x}$ ms^{-2} then x is:



42. An electric bulb is designed to consume 55 W when operated at 110 volts It is connected to a 220 V, 50 Hz line through a choke coil in series. The inductance of the coil in series for which the bulb gets correct voltage is $\frac{x\sqrt{3}}{10}$H. Find the value of X. (Take $\pi = \frac{22}{7}$)

43. Consider a uniformly charged non-conducting cube of volume charge density ρ. Potential of one of vertex is 4 volt, find the potential of centre of the cube (in volts).

44. A wedge of mass 2m and a cube of mass m are shown in figure. Between cube and wedge, there is no friction. The minimum coefficient of friction between wedge and ground so that wedge do not move is x/10 find the value of x.



SECTION-1 : (One or more option correct type)

This section contains **12 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** are correct.

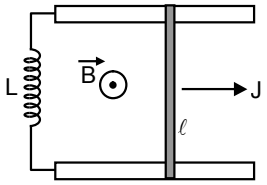
22. Two parallel resistance less rails are connected by an inductor of inductance L at one end as shown in the figure. A magnetic field B exists in the space which is perpendicular to the plane of the rails. Now a conductor of length ℓ and mass m is placed transverse on the rails and given an impulse J towards the rightward direction. Then choose the correct option (s).

(A) Velocity of the conductor is half of the initial velocity after a displacement of the conductor $d = \sqrt{\frac{3J^2L}{4B^2\ell^2m}}$

(B) Current flowing through the inductor at the instant when velocity of the conductor is half of the initial velocity is $i = \sqrt{\frac{3J^2}{4Lm}}$

(C) Velocity of the conductor is half of the initial velocity after a displacement of the conductor $d = \sqrt{\frac{3J^2L}{B^2\ell^2m}}$

(D) Current flowing through the inductor at the instant when velocity of the conductor is half of the initial velocity is $i = \sqrt{\frac{3J^2}{Lm}}$



23. An ideal inductor, (having initial current zero) a resistor and an ideal battery are connected in series at time t = 0. At any time t, the battery supplies energy at the rate P_B, the resistor dissipates energy at the rate P_R and the inductor stores energy at the rate P_L.

(A) $P_B = P_R + P_L$ for all times t. (B) $P_R < P_L$ for all times t.

(C) $P_R < P_L$ just after circuit is closed at t = 0 (D) $P_R > P_L$ just after circuit is closed at t = 0

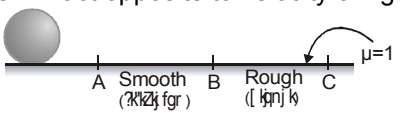
24. A rigid body undergoing pure rolling encounters horizontal rigid tracks AB and BC as shown. AB is smooth surface and BC is rough surface with μ = 1. Which of the following statements is/are **correct** :

(A) Angular momentum of the rigid body is conserved only about a point on the horizontal surface.

(B) Angular momentum of the rigid body is conserved about every point in space.

(C) In part BC, there will be no frictional force on the rigid body.

(D) In part BC, frictional force will act opposite to velocity of rigid body.



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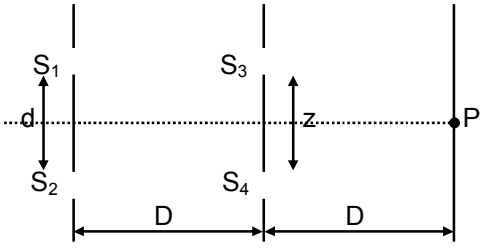
25. Consider the arrangement shown in figure. By some mechanism, the separation between the slits S_3 and S_4 can be changed. The intensity is measured at the point P which is at the common perpendicular bisector of S_1S_2 and S_3S_4. When $z = \frac{D\lambda}{2d}$, the intensity measured at P is I. Then select the correct alternative.

(A) When $z = \frac{D\lambda}{3d}$, Intensity at P is $\frac{3I}{2}$

(B) When $z = \frac{D\lambda}{d}$, Intensity at P is zero

(C) When $z = \frac{3D\lambda}{2d}$, Intensity at P is I.

(D) When $z = \frac{2D\lambda}{d}$, Intensity at P is 2I.



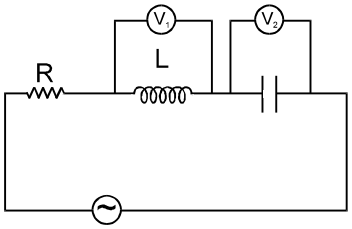
26. In the circuit shown, resistance R = 100 Ω, inductance $L = \frac{2}{\pi}$ H and capacitance $C = \frac{8}{\pi}\mu F$ are connected in series with an ac source of 200 volt and frequency 'f'. If the readings of the hot wire voltmeters V_1 and V_2 are same then :

(A) f = 125 Hz

(B) f = 250 π Hz

(C) current through R is 2A

(D) $V_1 = V_2$ = 1000 volt



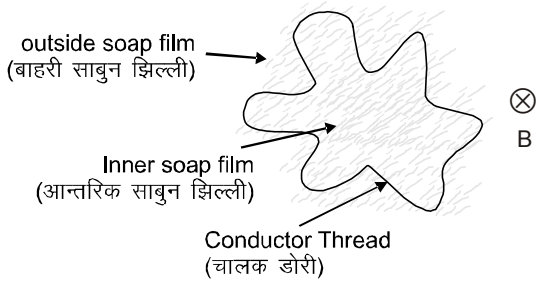
27. A conducting loop made of thin, light thread has a soap film inside and outside it. Length of thread is ℓ, total resistance is R, and initially area surrounded by it is $A_i = \frac{\ell^2}{8\pi}$. It is kept in a uniform magnetic field B directed inwards and then a small puncture is made in inner film.

(A) Current is continuously induced in the loop.

(B) Current is induced in the loop for some time and then it will be zero.

(C) Induced current will be anticlockwise as seen from above.

(D) Total charge flown through the loop will be $\frac{B\ell^2}{8\pi R}$



PHYSICS

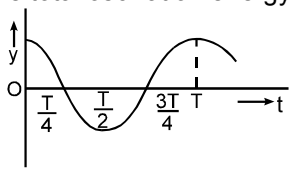
28. The displacement time graph of a particle executing S.H.M. (in straight line) is shown. Which of the following statements is/are true ?

(A) the speed is maximum at t = T/2

(B) the magnitude of acceleration is maximum at t = T

(C) the force is zero at t = 3T/4

(D) the potential energy equals the total oscillation energy at t = T/2



29. If ρ is the density of the material of a uniform rod and σ is the breaking stress , and the length of the rod is such that the rod is just about to break due to its own weight when suspended vertically from a fixed support, then

(A) length of the rod is $\frac{\sigma}{\rho g}$

(B) stress at a cross section perpendicular to the rod, at one fourth the length of the rod above its lowest point is $\frac{\sigma}{4}$

(C) stress at all horizontal sections of the rod is same

(D) the rod is about to break from its mid point

30. A uniform disc of radius R lies on the x-y plane with its centre at origin. Its moment of inertial about z-axis is equal to its moment of inertia about an axis along the line $y = K_1x + K_2$ where K_1 and K_2 are constants. Then choose the option (s) having possible values of K_1 and K_2.

(A) $K_1 = 1, K_2 = +\frac{R}{\sqrt{2}}$ (B) $K_1 = 1, K_2 = -\frac{R}{2}$

(C) $K_1 = -1, K_2 = +\frac{R}{2}$ (D) $K_1 = -1, K_2 = -\frac{R}{\sqrt{2}}$

31. A copper wire of negligible mass, 1m length and cross-sectional area 10^{-6} m^2 is kept on smooth horizontal table with one end fixed. A ball of mass 1 kg is attached to the other end. The wire and the ball are rotating with an angular velocity 20 rad/sec, and the elongation in the wire is 10^{-3} m. If on increasing the angular velocity to 100 rad/sec, the wire breaks down then

(A) the breaking stress is 10^{10} N/m^2 (B) the young's modulus is 4×10^{11} N/m^2

(C) the breaking stress is $2 \times 10^{10} N/m^2$ (D) the young's modulus is 8×10^{11} N/m^2

32. Two concentric coil of radii r_1 and r_2 ($r_1 << r_2$) carry currents i_1 and i_2 respectively. If the smaller coil is rotated slightly about one of its diameter it starts oscillating. Then choose the correct statements.

(A) The oscillations are simple harmonic in nature

(B) The frequency of oscillation is proportional to product i_1i_2.

(C) The frequency of oscillation is proportional to square root of r_2.

(D) The frequency of oscillation is independent of radius r_1.

33. Instantaneous voltage and instantaneous current in an LR circuit in AC is V = 100 sin (100t) and i = 10 sin(100t – π/4) Then choose the correct option.

(A) The impedance of the circuit is 10 units (B) The impedance of the circuit is $\frac{10}{\sqrt{2}}$ units

(C) Average power in one cycle is zero units (D) Average power in one cycle is $250\sqrt{2}$ units

SECTION – 2 : (Paragraph Type)

This section contains **3 paragraphs** each describing theory, experiment, data etc**. Nine questions** relate to three paragraphs with three questions on each paragraph. Each question of a paragraph has **only one correct answer** among the four choices (A), (B), (C) and (D).

Paragraph for Questions 34 and 36

A particle of mass m is attached to one end of a light elastic string of natural length ℓ and modulus 2mg. Modulus 2mg means 2mg force is required to stretch the string by ℓ from natural length. The other end of the string is attached to a fixed point O. With the string vertical, the particle is pulled down a distance ℓ below the equilibrium position and then released at t = 0. T_1 is the first instant when particle acquires the natural length. T is the time period of oscillation of the particle. H_{max} is the maximum height reached by the particle from the instant t = 0.

34. $T_1 = \lambda\sqrt{\frac{\ell}{g}}$ where λ =

(A) $\frac{2\pi}{3}$ (B) $\frac{\pi\sqrt{2}}{3}$ (C) $\frac{2\pi}{\sqrt{3}}$ (D) $\frac{\pi}{3\sqrt{2}}$

35. $T = \beta\sqrt{\frac{\ell}{g}}$ where β =

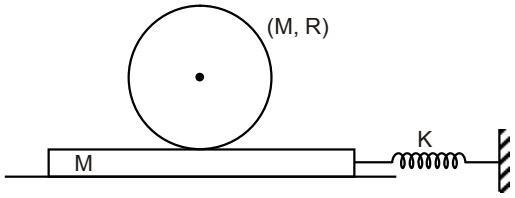
(A) $\left(\sqrt{6}+\frac{4\pi}{3}\right)$ (B) $\left(\sqrt{6}+\frac{4\pi}{3\sqrt{2}}\right)$ (C) $\left(6+\frac{4\pi}{3}\right)$ (D) $\left(6+\frac{4\pi}{3\sqrt{2}}\right)$

36. $H_{max} = \eta\ell$ where η =

(A) (9/2) (B) 3 (C) (9/4) (D) (9/5)

Paragraph for Questions 37 and 39

A cylinder of mass M and radius R lies on a plank of mass M as shown. The surface between plank and ground is smooth, and between cylinder and plank is rough. Assuming no slipping between cylinder and plank, and velocity amplitude of oscillation of plank V.



37. Time period of oscillation of the set up when displaced from equilibrium is

(A) $2\pi\sqrt{\frac{M}{3K}}$ (B) $4\pi\sqrt{\frac{2M}{3K}}$ (C) $4\pi\sqrt{\frac{M}{3K}}$ (D) $\pi\sqrt{\frac{3M}{2K}}$

38. Friction between plank and cylinder when acceleration is maximum is

(A) $\frac{V}{3}\sqrt{\frac{MK}{2}}$ (B) $\frac{V}{2}\sqrt{3MK}$ (C) $\frac{V}{2}\sqrt{\frac{MK}{3}}$ (D) $\frac{V}{3}\sqrt{2MK}$

39. Amplitude of oscillation of plank is

(A) $V\sqrt{\frac{3M}{4K}}$ (B) $V\sqrt{\frac{3M}{2K}}$ (C) $V\sqrt{\frac{2M}{3K}}$ (D) $V\sqrt{\frac{4M}{3K}}$

Paragraph for Questions 40 and 42

A common method of forming a inductor is a *toroid* formed by winding a wire into close loops on a *torus* (the shape of the tube in a bicycle wheel or a long solenoid bent into the shape of a circle). Consider a toroid having a mean radius or r_M, a cross-sectional radius of r_C($<<r_M$) and a very large number of turns N. Assume a current I flowing through this toroid.

40. The magnetic induction along the circular axis of the toroid, B_T =
(A) $\mu_0 NI/2r_M$ (B) $\mu_0 NI/2\pi r_M$ (C) $\mu_0 NIr_C/2\pi r_M$ (D) $\mu_0 NI/2r_C$

41. The inductance of the toroid, L_T =
(A) $\mu_0 \pi N^2 r_C^2 / 2r_M$ (B) $\mu_0 N^2 r_C^2 / 2\pi r_M$ (C) $\mu_0 N^2 r_C^2 / 2r_M$ (D) $\mu_0 \pi N r_C^2 / r_M$

42. Magnetic field within the toroid is :
(A) Uniform and terminating
(B) Uniform and non-terminating
(C) Non-uniform and terminating
(D) Non-uniform and non-terminating

SECTION-1 : (Only One option correct type)

This section contains **5 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

23. Nuclei of radioactive element A are produced at rate ' t^2 ' at any time t. The element A has decay constant λ. Let N be the number of nuclei of element A at any time t. At time $t = t_0$, $\frac{dN}{dt}$ is minimum. Then the number of nuclei of element A at time $t = t_0$ is:

(A) $\frac{\lambda t_0^2 - 2t_0}{\lambda^2}$ (B) $\frac{\lambda t_0^2 - t_0}{\lambda^2}$ (C) $\frac{2t_0 - \lambda t_0^2}{\lambda}$ (D) $\frac{t_0 - \lambda t_0^2}{\lambda}$

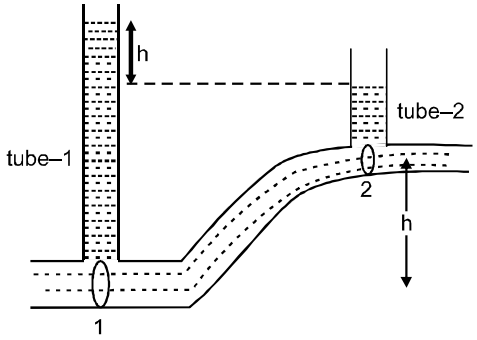
24. A non–viscous fluid of density ρ is flowing in a tube as shown in figure. Area of section–(1) is double that of section–(2). Centre of mass of section–(2) is h height above the Centre of mass of section–(1) and level of water in tube–1 is 'h' height above that in tube–2. Then :

(A) Velocity of fluid of section–(1) is $\sqrt{\frac{gh}{3}}$

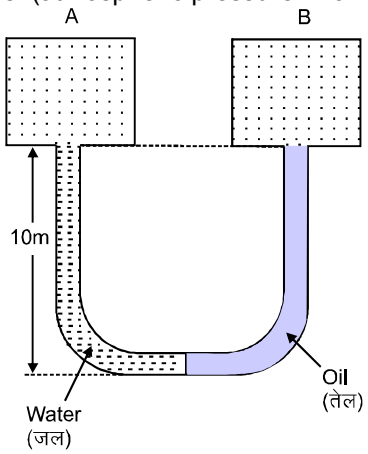
(B) Velocity of fluid at section–(1) is $\sqrt{\frac{2gh}{3}}$

(C) Work done by gravitational force per unit volume from section–(1) to section–(2) is = ρgh

(D) Work done by elastic forces (pressure) per unit volume from section–(1) to section–(2) is = $+3\rho gh$



25. One side of vertical U–tube contains water and other contains oil as shown in figure. The ends of the tube are connected to the two vessels of same volume. Vessel A is filled with air at atmospheric pressure and vessel B is also filled with air but the absolute temperature inside vessel B is one fourth that of vessel A and number of moles inside vessel B is 5 times that of vessel A. The relative density of the oil is: (atmospheric pressure $=10^5$ Pa, g = 10 m/s^2)



(A) $\frac{2}{3}$ (B) $\frac{3}{4}$ (C) $\frac{1}{2}$ (D) $\frac{1}{3}$

26. A nucleus with mass number 220 initially at rest emits an α particle. If the Q value of the reaction is 6.50 MeV and only one photon of energy 1.00 MeV is subsequently emitted after the emission of the α particle, the kinetic energy of the α particle is:
(A) 5.50 MeV (B) 5.40 MeV (C) 4.50 MeV (D) 4.00 MeV

27. The electric field of an electromagnetic wave changes with time as $E = K(1 + \cos\Omega t)\cos\omega t$, where $\Omega = 5 \times 10^{15}\ s^{-1}$, $\omega = 2 \times 10^{16}\ s^{-1}$ and K is constant. This radiation is incident on a sample of hydrogen atoms initially in ground state. Assume that atoms absorb light as photons. Neglecting recoil of hydrogen nucleus on ionisation, what will be the energy of ejected electrons from hydrogen. [The ionisation energy of hydrogen atom = 13.6 eV and $h = 2\pi \times 6.6 \times 10^{-16}$ eV-s]
(A) 0.7 eV (B) 0.9 eV (C) 1.4 eV (D) 2.9 Ev

SECTION-2 : (One or more option correct type)

This section contains **10 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** are correct.

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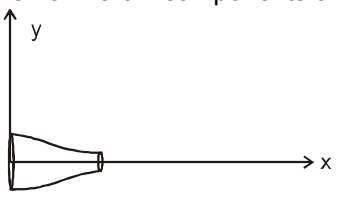
28. A neutron with kinetic energy 70 eV collides in-elastically with a stationary He^+ atom (in ground state) and neutron is scattered at right angle to the original direction of its motion. After collision the electron in He^+ atom is transferred to the third excited state, then after collision (take $M_{He} = 4m_N$). Choose the correct option.
(A) kinetic energy of He^+ atom is 17.8 eV
(B) kinetic energy of neutron is 1.2 eV
(C) kinetic energy of neutron is 2.2 eV
(D) six wavelengths are likely to be emitted after atoms get de-excited.

29. In a certain gravity free space, the piston of an injection is being pushed so that the water jet comes out with a speed v. The area of the piston is much greater than the orifice of the jet.
(A) The force required to be applied on the piston is proportional to v^2.
(B) The power developed by the force pushing the piston is proportional to v^3.
(C) The time for emptying the injection is proportional to v^{-1}.
(D) The total work done in emptying the injection is proportional to v^2.

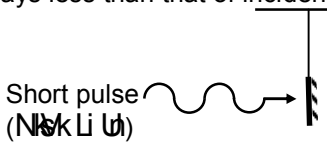
30. When a monochromatic point source of light is at a distance of 0.2 m from a photoelectric cell, the cut-off voltage and the saturation current are respectively 0.6 V and 18.0 mA. If the same source is placed 0.6 m away from the photoelectric cell, then
(A) the stopping potential will be 0.2 V (B) the stopping potential will be 0.6 V
(C) the saturation current will be 6.0 mA (D) the saturation current will be 2.0 mA

31. A tube with varying cross – sectional area is shown in figure. The tube is symmetrical about x axis. A steady, incompressible & irrotational flow exists in the tube in the +ve x direction. The flowing fluid is non-viscous. Select correct option(s) regarding the fluid element present inside tube.
(A) The velocity of all fluid elements is in x direction only.
(B) The velocity of all fluid elements lying on the x axis is in x direction only
(C) Some fluid elements may have non zero y components of velocity
(D) Some fluid elements may have non zero z components of velocity



PHYSICS

32. A small mirror is suspended by a thread as shown in figure. A short pulse of monochromatic light rays is incident normally on the mirror and gets reflected, which of the following statements is/are correct ?
(A) Mirror will start to oscillate.
(B) Wave length of reflected rays will be same as that of incident rays.
(C) Wave length of reflected rays greater than that of incident rays.
(D) Wave length of reflected rays less than that of incident rays.

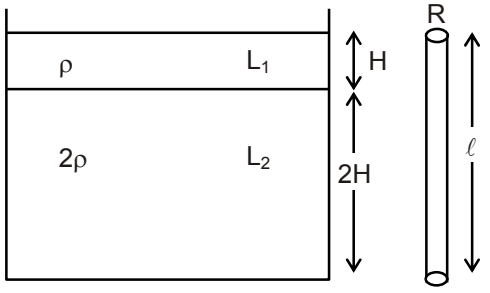


33. Photon absorbed in matter is converted in to heat. A source emitting n photon/sec of frequency ν is used to convert m kg of ice at 0°C to water at 0°C. Then time t taken for the conversion.
(A) decreases with increasing m, with n and ν fixed
(B) decreases with increasing n, with m and ν fixed
(C) remains constant if $n\nu$ = constant and m fixed.
(D) increases when the product $n\nu$ increases.

34. The threshold wavelength for photoelectrons emission from a material is 5200Å. Photo electrons will be emitted when this material is illuminated with monochromatic radiation from a :
(A) 50 W infrared lamp (B) 100 W infrared lamp
(C) 50 W ultraviolet lamp (D) 100 W ultraviolet lamp

35. X-ray from a tube with a target A of atomic number Z shows strong K_α lines for target A and two weak K_α lines for impurities. The wavelength of K_α lines is λ_0 for target A and λ_1 and λ_2 for two impurities respectively. $\frac{\lambda_0}{\lambda_1} = 4$ and $\frac{\lambda_0}{\lambda_2} = \frac{1}{4}$. The screening constant of K_α lines is unity. Select the correct alternative(s) :
(A) The atomic number of first impurity is 2Z – 1
(B) The atomic number of first impurity is 2Z + 1
(C) The atomic number of second impurity is $\frac{Z+1}{2}$
(D) The atomic number of second impurity is $\frac{Z}{2} + 1$

36. The lower end of pipe of length ℓ (ℓ > 3H) is closed and then dipped into the liquid such that, lower end of the pipe is at a depth of H in liquid L_2 and then opened, (angle of contact for liquid L_1 is 60º and for liquid L_2 is 0º, surface tension for L_1 is 2T and for L_2 is T). Assume $H = \frac{T}{R\rho g}$.
(A) height raised by liquid L_2 in the pipe from lower end of tube is $\left(\frac{5H}{2}\right)$
(B) height raised by liquid L_2 in the pipe from lower end of tube is $\left(\frac{3H}{2}\right)$
(C) both liquid insert into the pipe
(D) only liquid L_2 insert in the pipe



37. A solid sphere has terminal velocity of 10 ms^{-1} in a tall column of viscous liquid whose density is small compared to the solid, in a region where g = 10 ms^{-2}. If the set up is placed in a gravity free region and if the sphere is placed on the surface of the liquid and given an initial downward velocity of 10 ms^{-1}, then :

(A) Acceleration decreases linearly with velocity
(B) Velocity increases linearly with time
(C) Acceleration decreases exponentially with time
(D) Velocity increases exponentially with time

SECTION – 3 : (Matching List Type)

This section contains **2 multiple choice questions. Each questions has matching lists.** The codes for the lists have choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

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38. The ground state energy of hydrogen atom is –13.6 eV. A sample of hydrogen atoms in its ground state is irradiated with photons of energy 10.2 eV. The radiations from the above sample is then incident on two sample containing excited He^+ ions and excited Li^{2+} ions respectively. Both the samples absorb the radiations. (use hc = 12400 eVÅ)

List-I	**List-II**
(P) No. of spectral lines obtained in the Spectra of Li^{2+}	(1) 6
(Q) No. of spectral lines obtained in the Spectra of He^+	(2) 15
(R) Smallest wavelength in spectra of He^+ is (48.8X) Å then X (Approx.) is	(3) 5
(S)Smallest wavelength in spectra of Li^{2+} is (10.4Y) Å then Y (Approx.) is	(4) 10

Codes

	P	Q	R	S
(A)	3	1	1	4
(B)	2	1	1	2
(C)	2	1	3	4
(D)	3	1	3	2

39. Match List-I with List-II and select the correct answer using the codes given below the lists :

List-I	**List-II**
(P) A piece of ice cube is kept in a container starts acceleration down wards with 5 ms^{-2}	(1) Level of liquid in the container falls
(Q) A piece of ice cube melts in water	(2) Level of fluid in container remains same
(R) A piece of ice cube melts in oil of specific gravity 0.95	(3) Buoyant force decreases
(S) A piece of wood floats in water supporting a coin overhead and then the coin falls in water	(4) Buoyant force increases

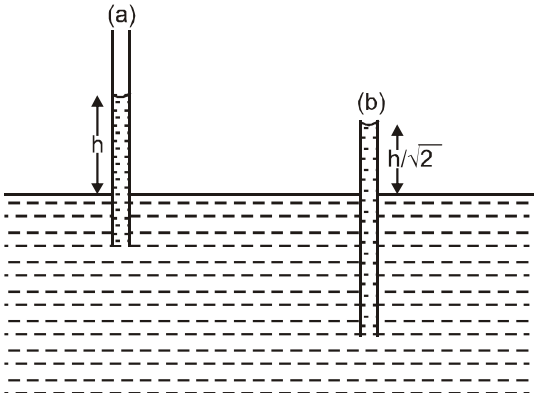
Codes :

	P	Q	R	S
(A)	3	1	2	4
(B)	3	2	1	1
(C)	2	3	2	1
(D)	4	1	2	3

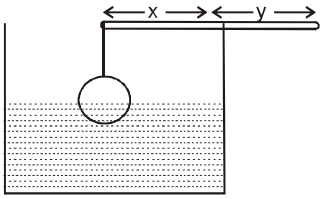
SECTION-4 : (Integer value correct Type)

This section contains **5 questions.** The answer to each question is a **Two digit integer,** ranging from 00 to 99 (both inclusive).

40. Two different vertical positions (a) & (b) of a capillary tube are shown in figure with the lower end inside water. For position (a), contact angle is $\frac{\pi}{4}$rad & water rises to height h above the surface of water while for position (b) height of the tube outside water is kept insufficient & equal to $\frac{h}{\sqrt{2}}$ then contact angle becomes $\frac{\pi}{x}$rad , then x is :

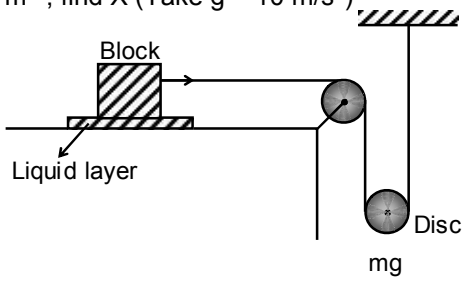


41. A homogeneous aluminium ball of volume 2 x10^{-6} m^3 is suspended on a weightless thread from an end of a homogeneous rod of mass 4.4g. The rod is placed on the edge of a tumbler with water so that half of the ball is 'submerged' in water when the system is in equilibrium (see fig.). The densities of aluminium & water are 2.1 x 10^3 kg/m^3 & 1 x 10^3 kg/m^3 respectively. Determine y/x (see fig.). Ignore surface tension.

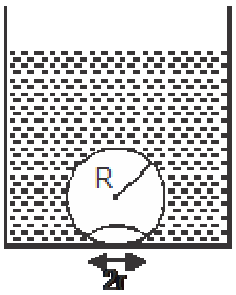


42. In the fusion reaction ${}_1^2\mathrm{H} + {}_1^2\mathrm{H} \longrightarrow {}_2^3\mathrm{He} + {}_0^1\mathrm{n}$, the masses of deuteron, helium and neutron expressed in a.m.u. are 2.015, 3.017 and 1.009 respectively. If 1 kg of deuterium undergoes complete fusion, the amount of total energy released is ***a*** × 10^{13} (in Joules) , find nearest integer of ***a***. (Given 1 a.m.u. ≡ 931.5 MeV/c^2)

43. A cubical block of side $10\sqrt{10}$ cm is connected to a smooth disc of mass 20 g through on ideal string as shown. The block is placed on a thin liquid layer of thickness 0.2 mm. Center of the disc move down with constant speed of 2 cm/sec after the system is released. If coefficient of viscosity of liquid is X × 10^{-4} NS m^{-2}, find X (Take g = 10 m/s^2)



44. On heating water, bubbles beings formed at the bottom of the vessel detach and rise. Take the bubbles to be spheres of radius R and making a circular contact of radius r with the bottom of the vessel. If r << R and the surface tension of water is T, value of r just before bubbles detach is (density of water is ρ) is $R^2\sqrt{\frac{\rho_w g}{\beta T}}$, find 6β.



PART : II PHYSICS

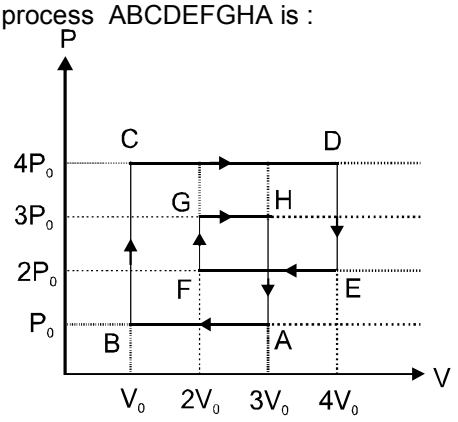
SECTION-1 : (Only One option correct type)

This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

23. A wire of density ρ is stretched between the clamps at a distance L apart, while being subjected to an extension ℓ(<<L), Y is the Young's modulus of the wire. The lowest resonant frequency of transverse vibration of the wire is approximately given by :

(A) $f = \frac{1}{2L}\sqrt{\frac{YL}{\ell\rho}}$ (B) $f = \frac{1}{2L}\sqrt{\frac{Y\rho L}{\ell^2}}$ (C) $f = \frac{1}{2L}\sqrt{\frac{Y\ell}{L\rho}}$ (D) $f = \frac{1}{2L}\sqrt{\frac{L\rho}{Y\ell}}$

24. The work done by gas in process ABCDEFGHA is :



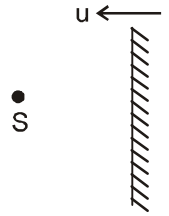
(A) $7P_0V_0$ (B) $-7P_0V_0$ (C) $9P_0V_0$ (D) $-9P_0V_0$

25. In Resonance tube experiment, if 400 Hz tuning fork is used, the first resonance occurs when length of air column in the tube is 19 cm. If the 400 Hz. tuning fork is replaced by 1600 Hz tuning fork then to get resonance, the water level in the tube should be further lowered by (take end correction = 1 cm and select correct options)

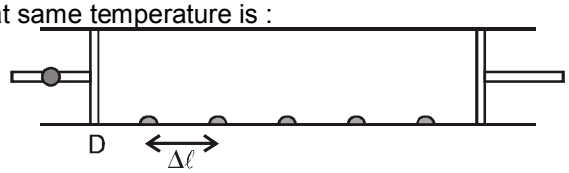
(A) 4 cm (B) 10 cm (C) 15 cm (D) 20 cm

26. A wall is moving with constant velocity u towards a fixed source of sound of frequency 'f'. The velocity of sound is 'v'. The wavelength of the sound reflected by the wall is

(A) $\frac{v-u}{f}$ (B) $\frac{v+u}{f}$ (C) $\frac{v-u}{v+u}.\frac{v}{f}$ (D) None of these



27. In a Kundt's tube distance between two consecutive heap is $\Delta\ell$ for air, while it is increased by 50% for a gas in the same tube with same resonite. If speed of sound in air is $\frac{1000}{3}$ m/s then speed of sound in gas at same temperature is :



(A) 1500 m/s (B) 1000 m/s (C) 500 m/s (D) 250 m/s

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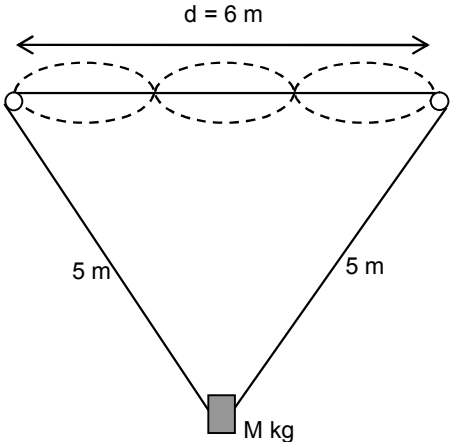
28. An object of mass 'M' kg hangs in equilibrium from a string with a total length of L = 16 m and linear density of μ = 0.01 kg/m, as shown in figure. The string is wrapped around two light small frictionless pulleys that are separated by distance d = 6 m. When the string between the pulleys vibrates to form the standing wave pattern with three loops on it, the frequency of vibration is 25 Hz. Find the value of M/2. (Take g = 10 m/s^2)



(A) 4 (B) 8 (C) 10 (D) 5

29. The amplitude of a wave represented by displacement equation $y = \frac{1}{\sqrt{a}}\sin\omega t \pm \frac{1}{\sqrt{b}}\cos\omega t$ will be :

(A) $\frac{a+b}{ab}$ (B) $\frac{\sqrt{a}+\sqrt{b}}{ab}$ (C) $\frac{\sqrt{a}\pm\sqrt{b}}{ab}$ (D) $\sqrt{\frac{a+b}{ab}}$

30. 56 gm of N_2 gas is passed through a reversible process in which internal energy changes with pressure (P) according to $U \propto P^2$. Initial temperature of the gas is T_0. During the process, if volume of the gas is doubled, then heat given to the gas will be :

(A) $3RT_0$ (B) $16T_0$ (C) $9RT_0$ (D) $18RT_0$

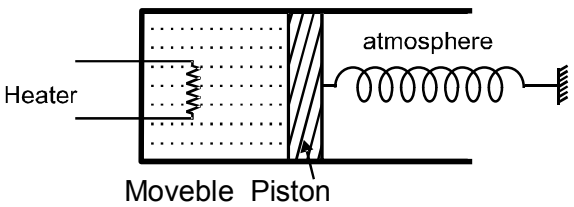
SECTION-2 : (One or more option correct type)

This section contains **8 multiple choice questions**. Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE** are correct.

31. An ideal gas is filled in a fixed cylinder as shown in figure. The initial temperature, pressure and volume of the gas are T_0, P_0 and V_0 respectively where P_0 is atmospheric pressure. A light and smooth piston of area A is connected to a spring of spring constant K, which is initially in natural length. Now the gas is heated slowly for some time, due to which the piston moves out slowly by a distance 'x'. Then :

(A) Pressure of the gas is $P_0 + \frac{Kx}{A}$ (B) Temperature of the gas is $\left(1+\frac{Kx}{P_0A}\right)\left(1+\frac{Ax}{V_0}\right)T_0$

(C) The gas is undergoing constant pressure process (D) Work done by the gas is $\frac{1}{2}Kx^2$



PHYSICS

32. A car moves towards a hill with speed v_C. It blows a horn of frequency f which is heard by an observer following the car with speed v_0. The speed of sound in air is v.

(A) the wavelength of sound reaching the hill is $\frac{v}{f}$

(B) the wavelength of sound reaching the hill is $\frac{v - v_c}{f}$

(C) The wavelength of sound of horn directly reaching the observer is $\frac{v + v_c}{f}$

(D) the beat frequency observed by the observer is $\frac{2v_c(v + v_o)f}{v^2 - v_c^2}$

33. An air column in a pipe closed at one end is made to vibrate in its second overtone by a tuning fork of frequency 440 Hz. The speed of sound wave in air is 330 m/s. End corrections may be neglected. Let P_0 denote the mean pressure at any point in the pipe, and ΔP_0 the maximum amplitude of pressure variation. Then :

(A) length of the pipe is $\frac{15}{16}$ m (B) length of the pipe is $\frac{9}{16}$ m

(C) the maximum pressure at the open end is P_0 (D) the minimum pressure at the open end is P_0

34. A wave pulse moving to the right along the x-axis is represented by the wave function $y(x, t) = \frac{2.0}{(x - 3.0t)^2 + 1}$, where x and y are in centimeters and t is in seconds. (The maximum pulse height is defined as maximum displacement along y-axis). Then

(A) The maximum pulse height is decreasing with time.
(B) The maximum pulse height is constant with time
(C) The speed of the pulse is 3.0 cm/s
(D) The speed of the pulse is 0.33 cm/s

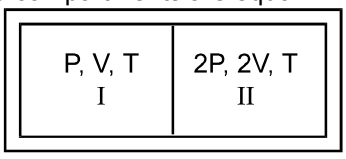
35. A partition divides a container having insulated walls into two compartments I and II. The same gas fills the two compartments whose initial parameters are given. The partition is a conducting wall which can move freely without friction. Which of the following statements is/are correct, with reference to the final equilibrium position?

(A) The Pressure in the two compartments are equal.

(B) Volume of compartment I is $\frac{3V}{5}$

(C) Volume of compartment II is $\frac{12V}{5}$

(D) The temperature in the two compartments are equal.



PHYSICS

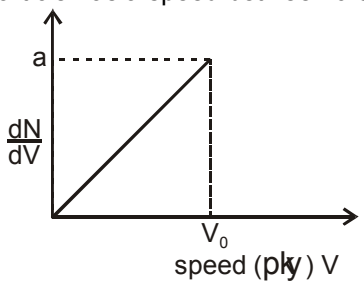
36. Graph shows a hypothetical speed distribution for a sample of N gas particle (for $V > V_0$; $\frac{dN}{dV} = 0$, $\frac{dN}{dV}$ is rate of change of number of particles with change velocity)

(A) The value of aV_0 is 2N.

(B) The ratio V_{avg}/V_0 is equal to 2/3.

(C) The ratio V_{rms}/V_0 is equal to $1/\sqrt{2}$.

(D) Three fourth of the total particle has a speed between 0.5 V_0 and V_0.



37. Consider a string fixed at one end and attached to a ring on other end as shown. Ring is around a smooth rod as shown such that it is free to move in y-axis. Two waves travel on this string. Equation of the waves are :

Wave-1 : $y = A \sin(\omega t + kx)$

Wave-2: $z = A \sin(\omega t + kx)$

Both waves get reflected by the rod attached to the ring.

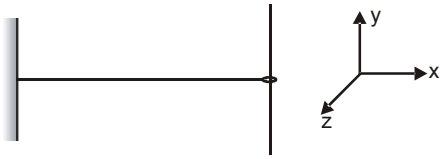
Then :

(A) No phase difference will be added in wave-1 due to reflection.

(B) π phase difference will be added in wave-1 due to reflection.

(C) No phase difference will be added in wave-2 due to reflection.

(D) π phase difference will be added in wave-2 due to reflection.



z-axis is out of plane of paper

(v{kdkxt dsry dsyEcor~gA

38. A monatomic & a diatomic gas both at the N.T.P. having same no. of moles are compressed adiabatically to half of initial volume :

(A) Increase in temp. will be more for the diatomic gas

(B) Increase in temp. will be more for the monatomic gas

(C) Increase in temp. will be same for both the gases.

(D) Increase in pressure will be more for the monatomic gas.

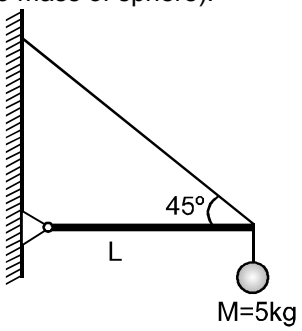
SECTION-3 : (Integer value correct Type)

This section contains **6 questions**. The answer to each question is a **single digit integer,** ranging from 0 to 9 (both inclusive)

39. A string fixed at both ends has consecutive standing wave modes for which distances between adjacent nodes are 6 cm and 4 cm. The length of the string is x (in cm). Find the value of $\frac{2x}{3}$:

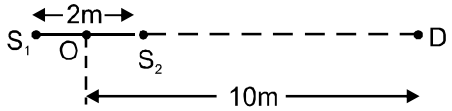
40. The average density of Earth's crust 10 km beneath the surface is 2.7 gm/cm^3. The speed of longitudnal seismic waves at that depth is 5.4 km/s. If the bulk modulus of Earth's crust considering its behaviour as fluid at that depth, is N × 10^{10} Pa then the value of N in the terms of nearest single digit integer is

41. A sphere of mass M = 5kg is supported by a uniform thin string that passes over a light horizontal rod of length L = 1m as shown in figure. The fundamental frequency of standing wave in the portion of the string above the rod is 50 Hz the angle θ is 45º. The mass of the string above the rod is x(gram). The value of x is: (Take g = 10 m/s^2 and mass of the thin uniform string is very-very small in comparision to mass of sphere).



42. How many degrees of freedom have the gas molecules, if under standard conditions STP the gas density is $\rho = \frac{1400}{1089}$ kg/m^3 and the velocity of sound propagation in it is ν = 330 m/s.

43. S_1 and S_2 are two stationary sources separated by a distance of 2m from each other producing sound at 1440 Hz in same phase. A detector D is moving in a circle of radius 10m around O (mid–point of line joining S_1 and S_2). If in one complete revolution it detects maximum intensity 'x' times then $\frac{x}{4}$ is : (Speed of sound = 360 m/s)



44. In the given arrangement shown in figure, a mass M is suspended with the help of string, which passes over a light pulley. The string is connected to a vibrator having constant frequency. The vibrator gives transverse oscillation to string. When the value of M is either 16 Kg or 25 Kg standing waves are observed, however, no standing waves are observed with any mass between these values. The largest mass for which standing waves could be observed is n × 10^2 Kg. Find the value of 'n'. (string is very light)